QUAHOG STANDING CROP SURVEY

New Bedford/Fairhaven Inner and Outer Harbors

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INTRODUCTION

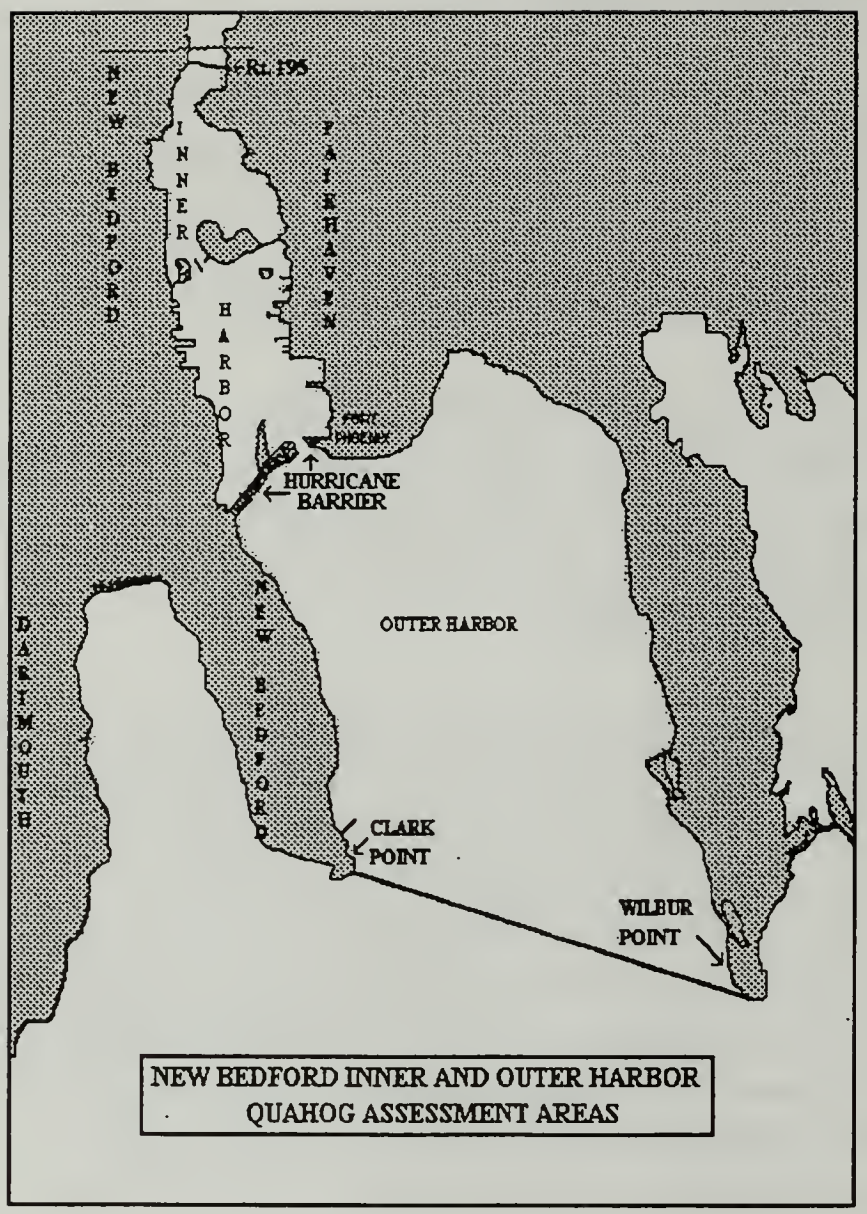
During the past several years, emphasis has been directed toward defining the explicit and subtle impacts of polychlorinated biphenyls (PCBs) on the environment and natural resources of greater New Bedford. Many local, state and national agencies and organizations have attempted to delineate the impacts and quantify potential losses to a point where restorations may be possible.

Obviously, shellfish, because they are filter-feeders and live in or on the substrate that was contaminated by the PCBs, are of prime concern in the restorative process. Additionally, the importance and validity of this study resides in the fact that contaminated relay potential needed to be assessed and quahog standing crop determined for the possibility of resource utilization.

Portions of this area have been previously studied by the Massachusetts Division of Marine Fisheries (DMF). The most recent survey and analysis was conducted between July 1980 and July 1981 by DMF (Hickey, 1983) and was intended as an assessment of quahog resources in contaminated waters of southeastern Massachusetts that may possibly be used for depuration. This survey addressed not only the quahog standing crop, but also resource value and utilization and a sustainable yield. In the New Bedford area, it encompassed the outer harbor south of the hurricane barrier and portions of the inner harbor from the barrier to Pope's Island, Clark Cove and waters just south of Clark Point. Additionally, another less definitive survey was conducted in 1966 by DMF (Carr, 1966) in portions of the outer harbor.

To determine the impact on the major shellfish in the area, the quahog (Mercenaria mercenaria), a comprehensive evaluation of this standing crop of both the inner and outer harbors of the estuary known as the Acushnet River was developed and initiated by the DMF. The areas assessed are described as the outer harbor north of a line drawn from Clark Point in New Bedford to Wilbur Point in Fairhaven and south of the hurricane barrier and the inner harbor north of the hurricane barrier and south of the Interstate 195 bridge spanning the Acushnet River (Fig. 1). This survey was intended to enable the Division to define both the quahog standing crop and note the ancillary specie affected for the projected area of the two harbors. Although quahogs were generally targeted as the primary animal of investigation, all other shellfish types retrieved during the sampling process were noted.

FIGURE 1



NEW BEDFORD INNER AND OUTER HARBOR
QUAHOG ASSESSMENT AREAS

An adjunct investigation of the water quality of the New Bedford inner and outer harbors and the PCB and trace metal content of shellfish from selected locations was also conducted by the Division so as to further assess the condition of this marine environment and establish classification profiles relative to the water quality and the potential for shellfish harvesting. Historical evaluations of water quality conditions (Germano, 1992) provide further insight into the past and its potential toward future pollution. Results of the water quality surveys are in separate unpublished sanitary survey reports (Whittaker, 1996, 1999). The results of the PCB and trace metal analyses which was conducted by the DMF laboratory at the Annisquam River Marine Fisheries Station in Gloucester are incorporated in the PCB and Trace Metal Analysis section (Tables 4 and 5) of this report.

At the request of the New Bedford Harbor Trustee Council, DMF submitted a proposal to determine the potential and efficacy of quahog resource utilization in New Bedford. This plan outlined the technical and funding requirements of the project along with completion targets. Essentially, dredge boats, contracted from the local fleet, and local shellfishermen using hand tongs were contracted to assess the standing shellfish crop. This technique has been used successfully in past surveys to assess both deep and shallow areas respectively with comparable results.

After presentation and review, the project was funded by the Council and initiated. Due to contracting mandates and several other peripheral administrative requirements, actual survey efforts didn't get underway until the Spring of 1997. The first phases of the survey were conducted in the inner harbor. Second phase

analysis was conducted during the summer and fall of 1998 in the outer harbor.

Finally, a brief treatise on the contaminated shellfish relay program conducted by DMF is incorporated into this report in order to furnish an additional perspective on the quahogs removed from the outer harbor area and their relevance to the recruitment/yield factor of the outer harbor.

METHODS AND MATERIALS

General

Determining sites and methods relative to standing crop evaluations varies from the comparatively simple to the complex. Some sequential sampling methodologies using random sample sites and subsequent determinations of numerical abundance have been reviewed for application here (Saila, 1966). Other standing crop methods using dredge boats (Russell, 1972) were also evaluated. In the final analysis, however, the methods used by Hickey in 1983 and variations on those used by Joe DeAlteris (DeAlteris, 1998) were utilized.

Location of sample sites was determined using a grid system comprised of parallel transects with the number of stations selected, determined by the size of the area. Sampling intervals in the inner harbor were set on relatively square configurations of 300 yard squares. At least one sample station was located in each 300 yd^2 segment. One-hundred and sixty-five sites were sampled in the inner harbor. Where appropriate, dredge station sampling consisted of two one-hundred yard parallel tows with tow lengths being measured by onboard electronic equipment measuring over-the-bottom distance. Dredge data for square foot analysis were determined on the actual distance traveled multiplied by the area of the dredge. Quahog length frequencies were measured by enumerating all animals taken in each tow, taking a representative sub-sample if the sample was excessively large and measuring the longest shell diameter to the nearest millimeter.

Hand-tong sampling entailed enumerating and measuring every quahog in the sample hole along with noting other specie and substrate composition. Two different sized tongs were used; 12 inch by 17 inch and 12 inch by 14 inch with varying length stales (tong handles) to accommodate different depths. Tong openings were limited to a constant aperture of 12 inches using line tied to the stales. Sample holes were dug to a depth of nine inches. The actual area in ft^2 of the sample hole was determined by multiplying the width and opening (noted above) of the tongs.

All data was recorded on specifically designed data sheets with ten millimeter intervals starting at zero and ending at greater than 100. Data was transcribed into two automated personal computer systems; Rbase and Microsoft Excel where animals per ft^2, totals per length intervals and the number of animals per acre were calculated. Species other than quahogs taken in the sample were noted on the data collection forms but length frequencies were not recorded. This data was then transcribed to a report format organized by sampling unit areas (Subarea # in appendices) containing station length frequency information, bushel totals by acre and sampling unit area, size category tables and graphics illustrating length/ frequencies and percentages. To arrive at commonly used class sizes, (seed, littlenecks, cherrystones and chowders), information from the latest market surveys of shellfish dealers was used to convert metric sizes obtained during the sampling process to the more commonly used English system (inches). The millimeter ranges with their corresponding English system intervals:

Table 1
Class Size Lengths

	Seed	Littlenecks	Cherrystones	Chowder
mm	0 - 50	51 - 60	61 - 70	> 71
inches	0 - 2	2 - 2 3/8	2 3/8 - 2 3/4	> 2 3/4

Area determined in ft^2 and acres was calculated utilizing the dot grid method and aerial photographs.

Inner Harbor

A total of 165 stations located in ten sampling unit areas of the inner harbor between the hurricane barrier on the south and Route 195 on the north were sampled. This encompassed an area of approximately 402 acres with more than 53,831 ft^2 of substrate sampled.

Shellfish samples were collected using two methods. The contracted commercial fishing vessel Michael B, a 40 ft side-rigged dredge boat, used a hydraulic dredge traditionally employed in the commercial harvest of quahogs in the area. The forward section of the dredge consisted of a 22 in effective fishing width (opening at the blade); a high-pressure water manifold with thirteen (3/8

inch) nozzles supplied by a four inch hose and powered by a slant six cylinder Chrysler motor. The water pressure was maintained at approximately 50 to 55 lbs/in^2 and was used as a substrate conditioner immediately forward of the fishing blade or knife.

Handtongs manned by two contracted local commercial fishermen were used in the shallower areas of the study areas. The two sets of tongs noted above afforded effective fishing capacities or sampling sizes of 1.42 ft^2 and 1.17 ft^2 respectively. The tonging was conducted from 16 ft to 18 ft shellfishing skiffs that employed anchors on the bow and stern to better stabilize the boat and allow for a more accurate sample.

Outer Harbor

As with the inner harbor survey, a commercial fishing vessel, Debbie Lee was contracted for quahog sampling in the outer harbor. Essentially the same hydraulic process was used for sampling as noted above with the following vessel and equipment specifications: fishing vessel length, 42 ft; hydraulic pump system, 80 horsepower diesel engine pumping seawater through a four inch hose to a dredge manifold with eleven (3/8 in) nozzles; Loran C used to determine position and length of stations. The same methods and materials noted above were used to obtain the length-frequency data.

Dredge Coefficient

To determine the efficiency of a specific hydraulic dredge in a variety of substrates and conditions, a dredge effectiveness evaluation is necessary (Meyers, 1981). To accomplish this, a modification of Meyers' dredge efficiency analysis was implemented. This coefficient study was conducted by two Division SCUBA teams made up of two divers and a boat operator each. One diver from each team swam the length of the dredge track counting those quahogs left in the track and those in the windrows on either side of the track. A second diver took 1/4 m^2 samples every ten m along the track. Animal sizes were not specifically measured but rather allotted to the pre-determined size classes of seed, littleneck, cherrystone and chowder. The diveboat operator recorded counts, substrate type, other marine plants and invertebrates as reported by the divers. Dive stations were selected to compare dredge efficiency in different substrate conditions.

To establish the coefficient, a formula comparing the number of quahogs

taken by the dredge to the number taken by the divers was used. The percentage was then applied to all tows within similar substrates, resulting in a more accurate determination of quahog density. A total of 18 dredge coefficients sites were determined and utilized in this study.

Data Entry And Analysis

Data, including station latitude/longitude, dredge size, track lengths, size ranges, numbers and coefficients were recorded into Rbase and Excel computer software systems. Data was stratified by sampling unit areas and densities.

Standing Crop Determination

The calculation of the standing crop of quahogs by actual size ranges, size classes and number of bushels was accomplished using an area-density method utilizing the number of animals per ft^2 per sample. The density was calculated for each sampling unit area.

The number of quahogs per bushel was calculated using the above market information where littlenecks have 420 animals per bushel, cherrystones 240, and chowders 120. It is important to note for clarification purposes that the term "bushels" as used in the various studies is not uniform. Formerly, in the 1983 study a "bushel" was 80 lbs. Currently, the industry standard is 60 lbs. Total bushels of quahogs within size categories were calculated using the steps in the following formula:

$$X * Y = Z; \qquad Z/C = B; \qquad B/A = b$$

Where: X = avg number quahogs/class size
Y = ft^2 in sampling unit area
Z = total quahogs/class size
C = quahogs/bu, e.g., 420 littlenecks/bu
B = total bushels/sample unit area
A = acres within sampling unit area
b = bushels per acre within a sampling unit area

RESULTS

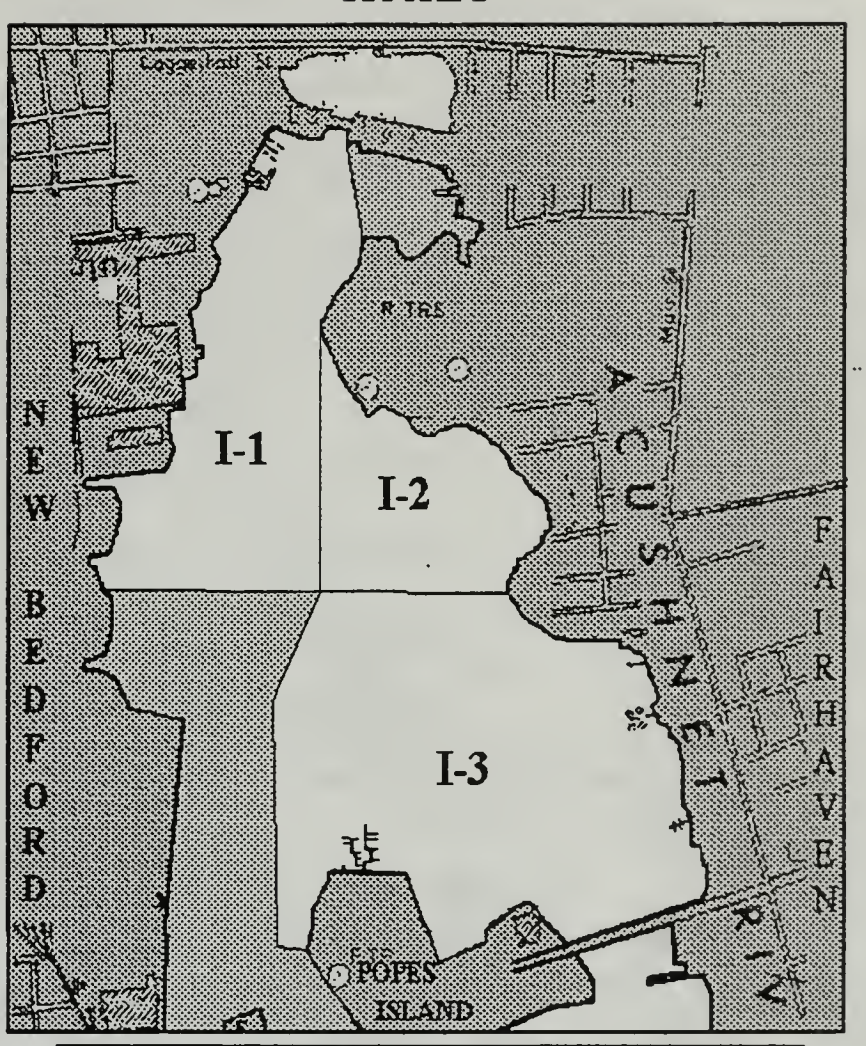
New Bedford Inner Harbor

Quahogs in varying population densities and size ranges were found throughout the area with the chowder size (> 71mm) constituting 40.81% of the

total standing crop. The cherrystone size category followed closely with 25.98%. These two size categories constitute approximately 67% of the standing crop. Littleneck comprise 17.9% and seed 15.31% of the standing crop.

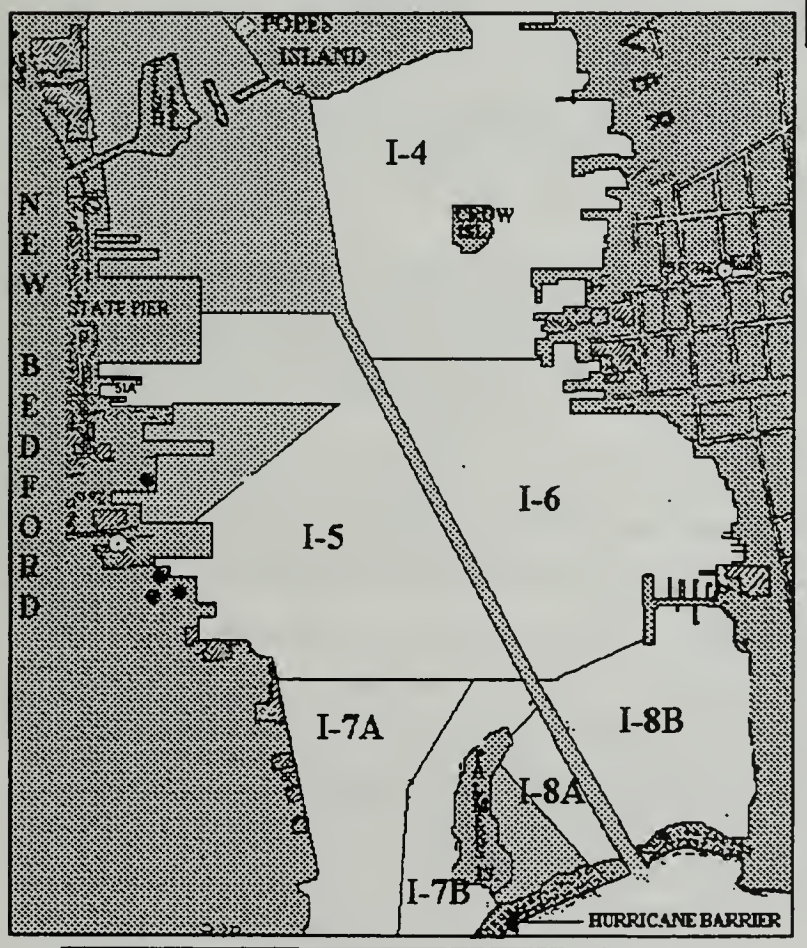
Observations indicate that the greatest percentages of "chowders" were found in sampling unit areas I-2 (Fig. 2) just south of Marsh Island and sampling unit area I-8A (Fig. 3) just northwest of the hurricane barrier opening. Significant percentages of greater than thirty for "cherrystones" were found in sampling unit areas I-3, along the Fairhaven shoreline just north of the Fairhaven Bridge, I-5 on the New Bedford shoreline fronting the fishing fleet piers, I-6 on the Fairhaven shoreline

FIGURE 2



NEW BEDFORD INNER HARBOR STANDING CROP SURVEY (UPPER PORTION)

FIGURE 3



NEW BEDFOR INNER HARBOR STANDING CROP SURVEY (LOWER PORTION)

fronting their fishing piers, and I-7A and I-7B in Palmer's Cove. Littlenecks in percentages greater than twenty were found in sampling unit areas I-3, I-5, I-7A and I-7B. Seed in abundances greater than ten percent were found in six of the ten sampling unit areas with sampling unit area I-4, on the Fairhaven shoreline just south of the Fairhaven Bridge, exhibiting the greatest at 18.93%.

The range of average adjusted quahog densities by size class for the inner harbor are: seed, 0.08/ft^2 to 2.28/ft^2; littlenecks, 0.16/ft^2 to

4.19/ft^2; cherrystones, 0.27/ft^2 to 6.07/ft2; and, chowders, 0.10/ft^2 to 6.60/ft^2. Table 1 presents the totals and percentages of the inner harbor standing crop.

Table 2
Quahog Standing Crop Assessment
New Bedford Inner Harbor

Area Square Feet	Area Acres				
17,495,874	401.65	**Seed**	**Littleneck**	**Cherrystone**	**Chowder**
	Total Quahogs	**16,680,452**	**21,346,744**	**28,333,211**	**44,534,264**
	Total Bushels		**50,826**	**118,055**	**371,119**
	Total Bushels/Acre:		**126.54**	**293.93**	**923.99**

Several other species were noted in varying abundances throughout the area. However, the distribution of soft shelled clams (Mya arenaria) in sampling unit areas, I-3, I-4, I-7A and I-7B and oysters (Crassostrea virginica) in sampling unit areas I-1, I-4, I-6, I-7A and I-7B is significant. In at least two tows in sampling unit area I-2, almost a bushel of soft shelled clams was landed in the dredge. The area just south of Palmer's Island contained approximately 15 clams per ft^2.

Large quantities of oysters and clams were also observed around Crow Island and Palmer's Island. Other specie noted during sampling along with substrate compositions and quahog length frequency information are found in Appendix I.

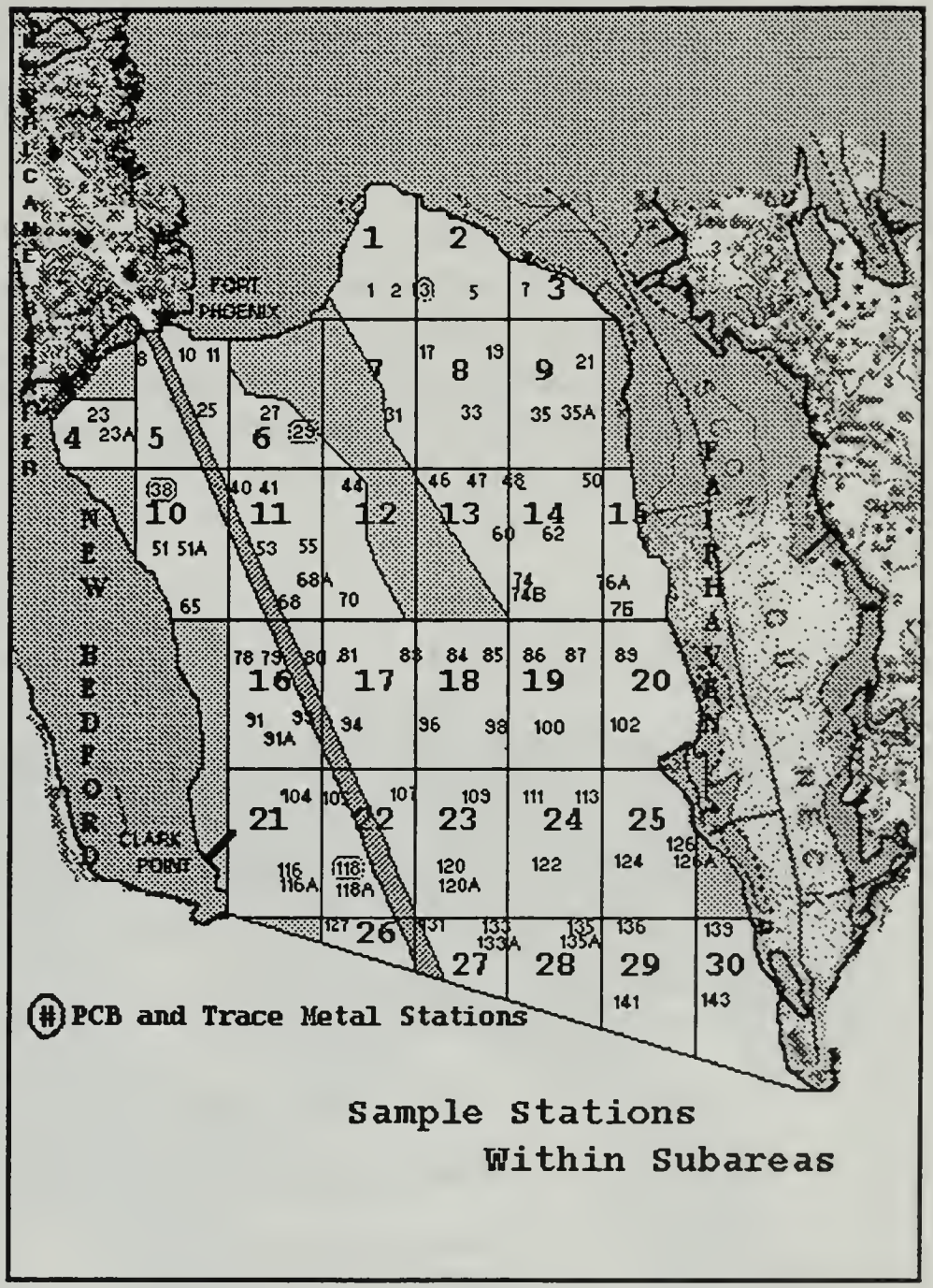
Substrate types in the inner harbor varied from a relatively large mud area in sampling unit area I-3 to firm sand and gravel with interstitial mud around Palmer's Island. Pockets of very soft, black mud are found scattered over the area. Quahog densities were found to be comparatively low at these locations with no seed observed and an average of 0.30 quahogs per ft^2 of the other three class sizes. Large quantities of debris ranging from soda cans to unknown "hangs" that literally stopped the forward progress of the dredge are found predominantly in the area between the hurricane barrier and the Fairhaven Bridge concentrated near the fishing fleet piers on either side of the harbor.

New Bedford Outer Harbor

A total of 86 stations within 30 sampling unit areas were sampled in the outer harbor (Fig. 4). The general area is described as that area south of the hurricane barrier and north of a line drawn from Clark Point in New Bedford to Wilbur Point in Fairhaven and is comprised of approximately 3750 acres.

As with the inner harbor survey results, quahogs were found in a wide range of density distributions throughout the outer harbor. However, the percentage of chowders was significantly higher. This may be an artifact of two major impacts on the quahog population; contaminated relays and a newly opened commercial fishery. Both of these fisheries have targeted the littleneck class size which may have resulted in a larger standing crop of cherrystones and chowders. For example, during the last two years, commercial landings from the New Bedford portion of the outer harbor were a total of 11,901 bushels (DMF 1997/1998 shellfish landing data). Of these, 71.5% were littlenecks and 28.5% were cherrystones and chowders.

FIGURE 4



NEW BEDFORD OUTER HARBOR
QUAHOG STANDING CROP SURVEY

Chowder percentages noted in the survey range from a high of 97.69% in a sampling unit area in the northeast portion of the harbor to a low of 34.19% in sampling unit area 26 in the southwest corner of the area. Additionally, it appears that none of the four sampling unit areas in the southwest part of the harbor, i.e., sampling unit areas 16, 21, 22 and 26 on the west side of the shipping channel support a large population of chowders.

Cherrystone distribution ranged from a high of 45.16% in sampling unit area 26 to a low of 0.64% in sampling unit area 9. Littleneck percentages ranged from 0.00% in sampling unit areas 25, 29 and 30 in the southeast portion of the area to 13.36% in sampling unit area 21 in the southwest corner of the area. Seed distribution ranged from 0.00% at five different sampling unit areas, most located in the southeast and northeast corner, to 19.28% in sampling unit area 4, in the northwest corner of the area.

The average range of adjusted quahog densities for the outer harbor are: seed, 0.00/ft^2 in the areas noted above to 0.1/ft^2 in sampling unit area 4; littlenecks, 0.00/ft^2 in the sampling unit areas noted above to 0.104/ft^2 in sampling unit area 23 located south-centrally just northeast of the shipping channel; chowders ranged from 0.03/ft^2 in sampling unit area 25 to 0.864/ft^2 in sampling unit area 2 in the northeast corner of the area. Table 3 presents totals for the outer harbor standing crop.

Table 3
Quahog Standing Crop Assessment
New Bedford Outer Harbor

Area Square Feet	Area Acres				
137,170,440	3149	**Seed**	**Littleneck**	**Cherrystone**	**Chowder**
	Total Quahogs:	**1,565,474**	**3,416,146**	**8,332,105**	**33,534,227**
	Percent of Total:	**3.34**	**7.29**	**17.29**	**71.58**
	Total Bushels:		**8,134**	**34,717**	**279,452**
	Avg. Bushels/Acre:		**2.58**	**11.03**	**88.74**

Other shellfish specie noted were knobbed whelk, channeled whelk, oysters and limpets. The most densely and widely distributed shellfish other that quahogs was Crepidula. These were found in every sampling unit area in varying levels of

vitality, i.e., limpet populations in some areas exhibited a rather high number of living animals, while in others it was almost total limpet shack (broken shells). Following limpets, codium (marine algae), was the next most abundant species. This alga forms a dense mat on the bottom and, if not moved along by tidal currents or winds, settles in depressions on the harbor floor. It breaks down and creates an undesirable and sometime anoxic environment for shellfish.

Substrates in the outer harbor appear to vary more widely than those of the inner harbor with larger regions of firmer materials. However, there are also areas of very soft, black mud scattered around with the most noteworthy being the southwest region west of the shipping channel in sampling unit areas 16, 21, 22 and 26. The substrate in this area is composed of thick, soft black mud which supports only a limited number of shellfish.

PCB and Metals Analysis

Seven bivalve mollusk samples were collected from areas within the inner harbor and four samples were collected from the outer harbor (Fig. 5). All samples were analyzed for PCBs (Table 4) and trace metals (Table 5). Sample sites were selected by their proximity to historically polluted sites. While all of the results provide information on PCB and trace metals, samples taken south of the Fairhaven Bridge in the inner harbor are especially important as they relate to the potential for future quahog resource contaminated relays from this area.

FIGURE 5

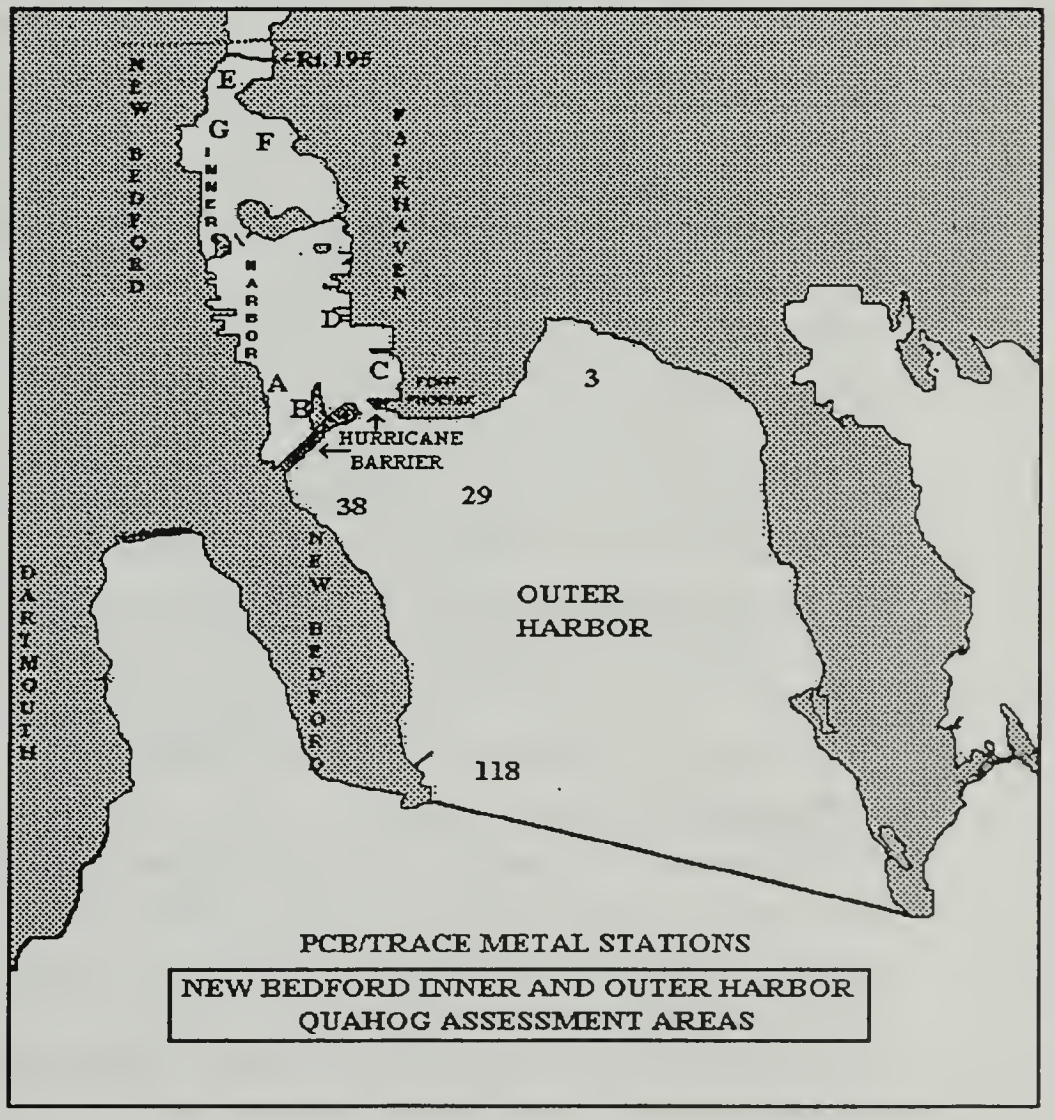


Table 4
PCB Analysis of Shellfish; Inner and Outer Harbor

Inner Harbor
(samples collected 4/25/97)

Station:	A	B	C	D	E	F*	G**
Parts/Million (ppm)[1]:	.58	.48	.30	.31	.84	3.60	2.40

Outer Harbor
(samples collected 8/21/98)

Station:	3	29	38	118A
Parts/Million (ppm)[1]:	.21	.21	.35	.17

*** American Oyster** **** Soft Shelled Clam** **All other shellfish samples were quahogs**

1. All concentrations are wet weight basis. FDA and MDPH Tolerance 2.0ppm

As illustrated above, most of the PCB levels fall within the standard guidelines (2.0 ppm)set forth as action levels for human consumption of seafoods in the *Guide For the Control of Molluscan Shellfish* published by the U. S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, 1997 Revision.

Table 7 lists the concentrations as parts per million wet weight of cadmium, chromium, copper, lead, and zinc in shellfish samples for each station. None of the samples exceeded the U.S. Food and Drug Administration level of concern for the consumption of molluscan bivalves of 3.7 ppm for cadmium (U. S. FDA, 1993a), 13 ppm for chromium (U. S. FDA 1993b) and 1.7 ppm for lead (U. S. FDA 1993c). Differences in copper and zinc concentrations were noted between species, particularly for American oyster. The National Status Trends Program (NOAA, 1989) found it necessary to perform spatial and temporal comparisons of copper and zinc tissue concentrations for each separate bivalve species due to strong species uptake preferences among different bivalves analyzed which included the American oyster. Differences in copper and zinc levels between species from the inner harbor may be attributed to species differences noted above.

Table 5
Metals Analysis (parts per million)

Inner Harbor:
(samples collected 4/25/97)

Station:	Cd	Cr	Cu	Pb	Zn	Shellfish Species
A	0.083	0.27	2.61	0.78	35.6	Quahog
B	0.058	0.26	2.77	0.60	36.6	Quahog
C	0.099	0.29	3.24	0.56	29.3	Quahog
D	0.109	0.53	2.51	0.83	31.4	Quahog
E	0.238	0.42	5.22	0.88	27.8	Quahog
F	0.803	0.65	110	0.69	1295	American Oyster
G	0.287	0.91	13.2	1.02	29.1	Soft Shelled Clam

Outer Harbor:
(samples collected 8/21/98)

3	0.060	0.58	1.29	0.31	21.6	Quahog
29	0.080	0.38	1.68	0.46	24.8	Quahog
38	0.087	0.24	2.72	0.58	29.3	Quahog
118A	0.105	0.25	2.46	0.25	13.6	Quahog

Value of Quahog Resource

The actual value of the various size classes of quahogs varies during the year and, if we use the price given to shellfishermen, dealer prices fluctuate widely as well. The following table was taken from studies by DMF in January 1999 and reflects the sizes and relative prices.

Table 6
Current Market Prices for Quahogs

Size Class	Wt/Bushel	Value/Pound	Value/Piece
Littleneck	60 lbs	$1.00 to $1.25	$0.14 to $0.20
Cherrystones	60 lbs	$0.25 to $0.30	N/A
Chowders	60 lbs	$0.20 to $0.25	N/A

Therefore, using the above figures, the value of the quahog fishery in the inner and outer harbors are noted below. The "Value to Fishermen" column denotes the dollars paid to fishermen by the dealers. To realize the gross value to the general community, however, these figures must be factored by the economic multiplier of 4.50 (Wong, 1968). The "Consumer Market Value" column reflects the total dollars after using the multiplier.

Table 7
Current Value of Quahogs for New Bedford Inner and Outer Harbors

Harbor	Littlenecks	Cherrystones	Chowders	Total Value to Fishermen	Consumer Market Value
Outer	$683,229	$625,494	$4,191,780	**$5,500,503**	**$24,752,264**
Inner	$3,811,950	$2,124,990	$5,566,785	**$11,503,725**	**$51,766,763**
Total	**$4,495,179**	**$2,750,484**	**$9,758,565**	**$17,004,228**	**$76,519,027**

OBSERVATIONS AND CONCLUSIONS

Sampling Observations

As noted above, densities of quahogs varied throughout both the inner and outer harbors and significantly from the inner harbor to the outer harbor. These variances are due to several factors, e.g., fishing pressures, predation, bottom types etc. and have been demonstrated in other standing crop surveys and treatises (Saila et al. 1965;66). However, as much as these factors contribute to contagious distribution of the animal, sampling biases may result in skewed representations of that distribution. Previous studies on quahogs populations sampled by use of dry dredges (Russell, 1972) were constructed around the stratified random sampling methodology where preliminary reconnaissance of an area served to identify areas of abundance resulting in density contours. Purely statistical manipulation of the data was then used to determine the efficiency of the sampling technique. Hickey, (1983) during his investigation of the standing crop of the inner and outer harbor modified this stratified random sampling method. His sampling protocol was enhanced with two significant features; by increasing the number of sampling sites and utilizing a dredge efficiency coefficient.

This study followed Hickey's sampling protocols as closely as possible. Changes in dredge technology (evolution from dry dredges to hydraulic) have enabled a more efficient sampling technique. To further insure a more accurate evaluation of the standing crop, this study used 21 dredge efficiency SCUBA dives which were substantially more than previous studies.

These sampling protocols were very effective, however, other factors influenced results. In order to arrive at a more acceptable mean for a sample site, parallel tows were taken at most stations with similar landing results, especially in the outer harbor. The inner harbor had several bottom obstructions that prevented tow comparisons. Mean sample densities were less variable on the closest parallel tows. Tidal current, wind, substrate composition and benthic cover additionally affected tow efficiencies. It appeared that the dredge method of fishing washed out many of the smaller animals since the two inch steel rings allowed for escapement. To correct for this bias, occasional complete dredge samples were collected to determine the percentage of seed lost. These samples were collected on a second parallel tow to insure similarity of bottom type. Minor differences in the number of seed and other class sizes between parallel tows were noted. Additionally, diver observations at coefficient sites were compared to dredge tow numbers resulting in no significant differences. I t should be noted that divers indicated that poor visibility occasionally precluded observation of seed along the sample track.

The most interesting comparison however, was the analysis of handtonging results of seed percentages relative to dredge results in the same sampling unit area. In sampling unit area I-7A, seed taken in tongs represented a mean of 3.5% while the dredge samples had 6.0% (see figure 3). In sampling unit areas I-7B and I-8B, results were considerably different; tongs 8.6% and 15.3%, dredge 8.86% and 8.67% respectively. The mean of the three areas was 9.1% seed taken in tongs and 7.84% taken in the dredge. These results are similar and indicate that the dredge is sampling seed quahogs at these stations.

Previously mentioned dredge coefficient factors used to determine the number of animals "missed" by the dredge varied widely among the 21 coefficient stations sampled depending upon the substrate and benthic cover of the sample site. For example, at station 118A in sampling unit area 22, the dredge was 100% efficient in that the divers found no quahogs after the dredge pass. On the other hand, a low of 11% efficiency was noted at station 135A in sampling unit area 28.

Because of these variables, the data was analyzed by grouping the stations into smaller sampling unit areas. This allowed for more precise spatial distribution projections. The use of comparable sampling methodologies in both the inner and

outer harbors and the similarity of techniques in prior DMF studies (Hickey, 1983) as well as those utilized by Normandeau Associates in a portion of the outer harbor assured the consistency of data and comparability of results.

Recruitment Potential

Noting the sampling biases above and the subsequent difficulties in determining the exact seed percentage in the standing crop, arrival at a precise number was not possible. However, analysis of the available information from the survey and results of previous studies provide a basis for generating recruitment estimates.

The graphs and tables (Appendices B and C) indicate considerable variability in the standing crops of the inner and outer harbors. The major reason for this difference is the intense fishing pressure in the outer harbor and the lack of harvesting in the inner harbor. The fishing pressure in the outer harbor may account for the pronounced differences in the littleneck and cherrystone size classes, but does not sufficiently address the larger percentage of seed in the inner harbor.

Seed levels at any point in time may vary widely due to density dependent and independent variables (Belding, 1912). Depending upon limiting factors, the volume of quahog spawn/set falls into three general categories: normal, most often; excellent, approximately every three to five years; and, "super" being approximately every eight to ten years. Although the seed percentage levels for both harbors are low compared to the other three size classes, the numbers of littlenecks, cherrystones and chowders indicate excellent recruitment. Reduced recruitment can be attributed to poor spawning, setting, or growing conditions, as well as inadequate broodstock from which to replenish the population. Other limiting factors include pollution, insufficient food source, and predation. In spite of the poor environmental conditions and the extremely high pollution levels in the inner harbor, the standing crop of quahogs is very high. Additionally, there is a much larger concentration of predators in the outer harbor than in the inner harbor.

Sustainable Annual Yield

As sustainable yield is related to recruitment, and the recruitment estimates of the outer harbor were conservative due to sampling bias, sustainable annual yield estimates are conservative. Assuming that the rate of recruitment does not change and harvesting continues at its current rate with similar market conditions, it appears

that quahog stocks may continue to decline in the "approved" areas.

The dredge boat fishery, consisting of approximately eight to ten active fishing vessels has been primarily targeting the littleneck and cherrystone sizes. Tow lengths vary, but according to one dredge boat captain, tow durations are approximately five minutes each and usually conducted at the rate of six tows per hour for six hours per day. An estimate of one boat during one fishing day indicates, that of the 1297 acres conditionally opened to shellfishing in the outer harbor, this boat may cover as much as 49,500 ft^2 of bottom (approximately 1.12 acres). Therefore, eight boats fishing an average of 90 to 100 days per year could cover approximately 896 acres. With a daily catch limit of 16 bushels of "mixed" (330 quahogs per bushel of mixed) quahogs per day, the total estimated annual catch could be 12,800 bushels, or 4,224,000 quahogs. Bullrakers, having five to seven boats harvesting on a given day, average two bushels per day over the same period noted above thus landing 1400 to 1600 bushels a year from a significantly smaller substrate base. Mortalities from the dredge are greater than those incurred by hand raking. During the sampling for this study , dredge tow mortalities accounted for 10 to 15% of the total numbers at certain stations. Divers take three bushels of littleneck and cherrystones per day during a 90 to 100 day period resulting in an estimated harvest of 1500 bushels. If we factor the above-noted mortality rate by the dredge total, the approximate potential number of bushels taken a year by all three methods may be 17,620 bushels (5,814,600 quahogs).

Comparing the above potential harvest and the previously noted average annual commercial landings as reported by the New Bedford shellfish constable for the last two years, the result differs minimally. This difference may be due to several factors, i.e., actual fishing days, total bushels taken per day, shellfish mortalities due to fishing pressures and reporting methodologies. Whatever the reason for the variation, maximum fishing pressure on the standing crop as described above would closely approximate the impact on the quahog population.

The impact on the substrate and the quahog population in the outer harbor is significant in that the 904 acres of substrate that is disturbed by rakes and dredges represents approximately 70% of the open fishable area. This impact and its potential for resource reduction has been substantiated by the diminished catch per unit effort as reported by the New Bedford shellfish constable and the general complaints of the dredge boat captains relative to dwindling stocks.

A second factor that may have a major impact on the quahog crop in the outer harbor during the last twenty to thirty years is the contaminated relay program administered by the Division of Marine Fisheries. Records have been kept on this

fishery from its inception. However, it has only been for the last twelve years that reliable data has been collected. Since 1986, a total of 87,247 bushels have been removed from the outer harbor and transplanted to other areas of the Commonwealth where they were allowed to depurate in waters classified "approved" for the taking of shellfish for human consumption. Almost all of these relays were conducted using power dredge boats in all areas of the harbor capable of accommodating them.

During the last three years, 32,066 contaminated bushels were transplanted in addition to the commercial harvest of 17,620. The commercial harvest totals represent approximately 12.1% of the standing crop (145,394 bushels) in the "approved" portion outer harbor (DMF catch reports). This falls well within the 20% traditionally allowed to insure a sustained yield (Holmsen, 1966). However, hydraulic harvesting may have a much more dramatic impact on the infaunal population than is illustrated by these removals. Various factors such as frequently turning over the same bottom, resuspension and subsequent deposition of silts, and redistribution of the predominantly mud substrate preclude optimum conditions required by seed and juveniles during initial stages of growth (Rice, 1989). Similarly, the practice of continuously returning unwanted class sizes to the water after culling has an unquantified deleterious impact. Additionally, mortalities of quahogs dredged in the winter appear to be higher as evidenced by events in 1997 in the outer harbor. While the causative factor has not been definitely established, it is believed that intensive hydraulic dredging has impeded stock recovery.

Contaminated Quahog Relay Potential

Prior to the initiation of the standing crop and sanitary surveys for the inner harbor, area towns were requesting the Division of Marine Fisheries for a contaminated relay program for the quahog stock between the hurricane barrier and the Fairhaven Bridge. The Division incorporated the contaminated relay potential into the standing crop survey. The standing crop assessment, together with the sanitary survey, will determine the classification of the area as it relates to fecal coliform contamination in the water column as dictated by the guidelines of the National Shellfish Sanitation Program's Guide For the Control of Molluscan Shellfish, 1997 Revision.

As noted above and illustrated below in the tables of Appendix I., there is a substantial standing crop of quahogs in the area between the hurricane barrier and the Fairhaven Bridge. Three areas of concentration that would provide the greatest relay potential are the area proximal to Crow Island, the eastern shoreline of

Fairhaven between the hurricane barrier and the commercial piers, and Palmer's Cove. Of these, Palmer's Cove would be the primary area. The location has had two recent PCB and trace metal surveys and was the site of an experimental contaminated quahog relay of 2200 bushels.

The standing crop survey in Palmer's Cove determined that there were 70,205 bushels of quahogs in the two sampling unit areas I-7A and I-7B (see figure 3). Of these, 7.47% were seed, 23.68% were littlenecks, 37.26% were cherrystones, and 31.58% were chowder. In sampling unit area I-8B, along the eastern shoreline just north of the barrier, there was a total of 87,915 bushels of which 10.27% were seed, 17.18% were littlenecks, 25.74% were cherrystones and 46.81% were chowders. The area around Crow Island, sampling unit area I-4 had a total of 105,340 bushels where 18.93% were seed, 19.37% were littlenecks, 26.23% were cherrystones and 35.46% were chowders.

All three of these locations offer substantial contaminated relay potential because of significant littleneck and cherrystones. However, Palmer's Cove is considered the premium site because of the large numbers of littlenecks. Due to the necessity for long-term depuration, littlenecks provide the best opportunity for resource harvesting after an extended closure period.

The potential for contaminated relays will be totally dependent on water quality findings of the sanitary survey and quahog tissue analysis.

Summary

This resource assessment and development of standing crop estimate has afforded a comparison of the inner harbor, where fishing has not been a factor, and the outer harbor where there has been relatively intense fishing pressure for the last three years. Comparing the percentages for both harbors indicates that the littleneck and cherrystone size classes were significantly impacted by fishing pressure. On the other hand, the chowder size class is 35% greater in the outer harbor with no apparent reason except selective harvesting of size classes.

One factor that may explain the comparatively high levels of seed, neck and cherry in the inner harbor, especially in Palmer's Cove and along the Fairhaven shoreline just north of the hurricane barrier is the location and construction of this barrier. Except for one or two small openings in the barrier and the shipping entrance itself, tidal flow is effectively restricted thus directing much of the tidal ebb carrying shellfish spat to the two areas, where it settles and grows.

As briefly mentioned above, the newly opened outer harbor has afforded the shellfishermen of New Bedford and Fairhaven a very productive fishery. Both the contaminated relay fishery and the commercial fishery have taken significant numbers of quahogs from the area with an intentional concentration on the littleneck and cherrystones. Because of this practice and the efficient harvesting by the hydraulic dredge, adjustments in catch limits and types have been made by the two towns in order to lessen the fishing pressure on the smaller classes and increase the harvest of chowders.

In summary, if managed properly, the outer harbor quahog resource will be able to support a viable fishery for the foreseeable future. Additionally, if water quality and source remediation measures undertaken by the City of New Bedford and the Town of Fairhaven continue in the positive direction, the potential for the opening of more shellfishing acreage is highly probable. The inner harbor, on the other hand, may take longer. Under the NSSP guidelines, fecal coliform levels here continue to constitute a "prohibited" classification thus precluding contaminated relays under existing protocols.

RECOMMENDATIONS

1. Transplanting contaminated quahogs from the current relay areas of the outer harbor classified as "restricted" (areas BB:15.7 and BB:15.52) should be continued with less emphasis on "littleneck" and "cherrystones" in order to allow these size classes to rebound over the next one to two years. Relays from these areas can be done by hydraulic dredge or hand-digging. Though dredging may be more efficient, depth and the existence of potentially beneficial fauna such as eel grass may dictate alternative harvesting methodologies. Greatest concentrations of quahogs are in the northeast and northern portions of the outer harbor. These areas should be initially targeted for relay with a potential harvest of six to seven thousand bushels. The remaining "restricted" portions of the outer harbor could support a relay of approximately 18,000 to 20,000 bushels per year (82 % chowders, 14 % cherry and 4% neck). and still insure sustainable yield. Consistent with recent DMF policy, relays from this area should continue to be limited to the towns of Dartmouth, New Bedford and Fairhaven.

2. DMF recommends a contaminated relay from Palmer's Cove, the vicinity of Crow Island and the Fairhaven shoreline immediately north of the hurricane barrier pending the results of the sanitary survey. Relay amounts should be no more than

20% of the standing crop of 263,460 bushels per year (52,692 bushels). DMF further recommends that a routine PCB and trace metal analysis be conducted on a quahog sample from these areas prior to the contaminated relay.

3. Municipal and town resource managers should consider strictly limiting the number of hydraulic dredge boats in the fishery to one per 100 acres of "approved" area.

4. Alternate sources of quahog replenishment stock should be considered, planned and implemented. For example, a combination of growing area rotation, contaminated relay and locally raised seed stock may be advisable. The City of New Bedford and the towns of Dartmouth and Fairhaven should continue the cooperative shellfish resource efforts that have been established during the last two years.

5. In order to more effectively plan and implement recommendations 1 through 4 above, the City of New Bedford and the towns of Dartmouth and Fairhaven should develop a shellfish resource management plan as outlined by DMF (appendix F).

6. An intense source remediation should be instituted by both New Bedford and Fairhaven to eliminate the pollution sources of the inner harbor. Targets, according to the sanitary survey conducted by DMF, should be a bacteriological treatment of Fairhaven wastewater effluent during the winter months and monitoring and treatment of CSOs and stormdrains in New Bedford that are found to be exhibiting high levels of fecal coliform.

7. In order to reduce the pollutants from the commercial and recreational fleets on both sides of the inner harbor, an extensive educational and regulatory program should be instituted immediately by New Bedford and Fairhaven..

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REFERENCES

Belding, D. L. 1912 (Reprint 1964). A report upon the quahog and oyster fisheries of Massachusetts. Mass. Div. Mar. Fish. 135p.

Carr, H. A. (Unpublished). 1966. Survey of contaminated quahog areas in New Bedford, Mass. Mass. Div. Mar. Fish. 3p.

DeAlteris, J., N. Thompson, and L. Skrobe. (Unpublished). 1998. Shellfish abundance estimates for eleven management areas in the Dartmouth, New Bedford, and Fairhaven region of Buzzards Bay. DeAlteris Assoc. Inc.

Germano, F. J. (Unpublished) 1992. The history of shellfish bacterial closures in Buzzards Bay 1900 to 1992. Mass. Div. Mar. Fish. 10p.

Hickey, J. M. 1983. Assessment of quahog stocks in contaminated waters of southeastern Massachusetts. Mass. Div. Mar. Fish. 31p.

Holmsen, A. And J. Stanislao. 1966. The economics of quahog depuration. Economics of Marine Resources:4. U.R.I. Agric. Exp. Sta. Bull. 384: 36 p.

Meyers, T. L., R. A. Cooper, and K. J. Pecci. 1981. The performance and environmental effects of a hydraulic clam dredge. Mar. Fish. Rev. 43 (9).

National Oceanic and Atmospheric (NOAA). 1989. National Status and Trends Program for Marine Environmental Quality-Progress Report: A summary of data on tissue contamination from the first three years (1986-1988) of the Mussel Watch Project. NOAA Tech. Mem. NOS OMA 49, Rockville, MD. 20852

Peterson, C. H., H. C. Summerson, and J. Huber. 1995. Replenishment of hard clam stocks using hatchery seed: combined importance of bottom type, seed size, planting season, and density. J. Shel. Res. 14(2):293-300.

Rice, M.A., C. Hickox, and I. Zehra. 1989. Effects of intensive fishing effort on the population structure of quahogs *Mercenaria mercenaria* (Linnaeus 1758), in Narragansett Bay. J. Shell. Res. 8(2): 345-354.

Russell, H.J. Jr. 1972. Use of a commercial dredge to estimate a hardshell clam population by stratified random sampling. J. Fish. Res. Bd. Canada 29:1731-1735.

Saila, S. B., and T. A. Gaucher. 1966. Estimation of a sampling distribution and numerical abundance of some mollusks in a Rhode Island salt pond. Proc. Nat. Shell. Assoc. 56:73-80.

Summerhayes, C. P., J. P. Ellis, P. Stoffers, S. R. Briggs, and M. G. Fitzgerald. 1977. Fine- grained sediment and industrial waste distribution and dispersal in New Bedford Harbor and western Buzzards Bay, Massachusetts. Woods Hole Ocean. Inst., Tech. Rpt. WHOI-76-115, Woods Hole, MA.

United States Food and Drug Administration (U.S. FDA). 1993a. Guidance document for cadmium in shellfish. Center for Food Safety and Applied Nutrition, 200C St. SW, Washington, D.C. 20204

United States Food and Drug Administration (U.S. FDA). 1993b. Guidance document for chromium in shellfish. Center for Food Safety and Applied Nutrition, 200C St. SW, Washington, D.C. 20204

United States Food and Drug Administration (U.S. FDA). 1993c. Guidance document for lead in shellfish. Center for Food Safety and Applied Nutrition, 200C St. SW, Washington, D.C. 20204

Whittaker, D. K. (Unpublished) 1996. Sanitary survey of New Bedford/Fairhaven outer harbor in the City of New Bedford and the Town of Fairhaven, BB:15.2. 21p.

Whittaker, D. K. (Unpublished) 1999. Sanitary survey of New Bedford/Fairhaven inner harbor in the City of New Bedford and Town of Fairhaven, BB:15.1. 14p.

Wong, E.F.M. 1968. A multiplier for computing the value of shellfish. Fed. Water Poll. Adm. U.S. Dept. Interior. 19 p.

APPENDIX A

Common and Scientific Names of Other Marine Organisms Noted During the Quahog Standing Crop Assessment

The following is a list of the common and *scientific names* of the marine animals **(fauna)** and plants **(flora)** that were noted during the quahog standing crop survey of **New Bedford Inner and Outer Harbors** and are used in the preceding text and Appendix B.

FAUNA

American Lobster	*Homarus americanus*
Blue Crab	*Callinectes sapidus*
Mud Crab	*Neopanope texana*
Green Crab	*Carcinus maenas*
Spider Crab	*Libinia emarginata*
Lady Crab	*Ovalipes ocellatus*
Hermit Crab	*Pagurus longicarpus*
Quahog (hard clam)	*Mercenaria mercenaria*
Quahog (variation)	*Mercenaria mercenaria notata*
Soft Shelled Clam	*Mya arenaria*
Eastern Oyster	*Crassostrea virginica*
Bay Scallop	*Argopecten irradians*
Razor Clam	*Ensis directus*
Ribbed Mussel	*Geukensia demissus*
Channeled Whelk	*Busycon caniliculatum*
Knobbed Whelk	*Busycon carica*
Ark (blood ?)	*Anadara spp.*
Cockle	*Cylcocardia spp.*
Quarterdeck Limpet	*Crepidula fornicata*
Jingle Shells	*Anomia simplex*
Common Starfish	*Asterias forbesi*
Polychaete Worm	*Nereis succinea*
Ribbon Worm	*Cerebratulus spp.*
Winter Flounder	*Psuedopleuronectes americanus*
Boring Sponge	*Cliona spp.*
Red Sponge	*Microciona prolifera*
Oyster Drill	*Urosalpinx cinerea*
Moon Snail	Genus and species not defined; probably Lunatia heros
Mantis Shrimp	*Squilla empusa*
Barnacle	*Balanus balanoides*
Pitar	*Pitar morrhuanus*
Periwinkle	*Littorina spp*
Blue Mussel	*Mytilus edulis*

FLORA

Rock Weed	*Fucus vesiculosus*
Tubed Weed	*Polysiphonia spp.*
Red Weed	*Agardhiella tenera*
Green Fleece	*Codium fragile*
Eel Grass	*Zostera marina*
Sea Lettuce	*Ulva lactuca*

Appendix B

Inner Harbor
Standing Crop Sample Data
Tables and Graphs

NEW BEDFORD INNER HARBOR
Subarea I-1

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I1	106	1,894,860	43.5	0.00	0.00	0.00	0.70
	112			0.00	0.00	0.70	2.11
	113			0.75	1.00	0.58	0.19
	114			0.16	0.21	0.95	1.22
	119			0.19	0.20	0.07	0.00
	120			2.82	2.11	4.93	11.97
	121			0.70	0.70	2.82	0.00
	122			0.21	0.85	0.92	0.26
			Avg./sqft:	**0.60**	**0.63**	**1.37**	**2.06**
			Total/Subarea:	**1,136,916**	**1,193,762**	**2,595,958**	**3,903,412**
			Total Bushels/Subarea:		**2,842**	**10,816**	**32,528**
			Total Bushels/Acre:		**65.34**	**248.65**	**747.78**

Other Species Noted: Many oysters (esp. along Revere bulkhead), many soft shelled clams (esp. Just south of Marsh Island), few mantis shrimp, few Crepidula,much ulva.

BottomType in Subarea: Relatively firm muddy sand throughout except for soft smelly mud area at stations 112 and 114.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-1	106	0.00%	0.00%	0.00%	100.00%
	112	0.00%	0.00%	25.00%	75.00%
	113	29.68%	39.68%	23.23%	7.42%
	114	6.25%	8.33%	37.50%	47.92%
	119	40.65%	43.17%	15.47%	0.72%
	120	12.90%	9.68%	22.58%	54.84%
	121	16.67%	16.67%	66.67%	0.00%
	122	9.23%	38.01%	41.33%	11.44%
	Avg. %:	**14.42**	**19.44**	**28.97**	**37.17**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 1; New Bedford Inner Harbor

NEW BEDFORD INNER HARBOR
Subarea I-2

Sub Area	Sta #	SqFt/ Subarea	Acres/ SubaArea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I2	108	1,200,078	27.55	0.05	0.25	0.75	2.39
	110			0.00	0.00	0.00	0.00
	111			0.70	0.70	3.52	10.56
	115			0.06	0.18	0.85	1.29
	116			0.70	0.00	0.00	1.41
	117			0.00	0.00	0.00	2.11
	118			0.00	0.00	0.70	2.11
			Avg./sqft:	**0.22**	**0.16**	**0.83**	**2.84**
			Total/Subarea:	**264,017**	**192,012**	**996,065**	**3,408,222**
			Total Bushels/Subarea:		**457**	**4,150**	**28,402**
			Total Bushels/Acre:		**16.59**	**150.65**	**1,030.92**

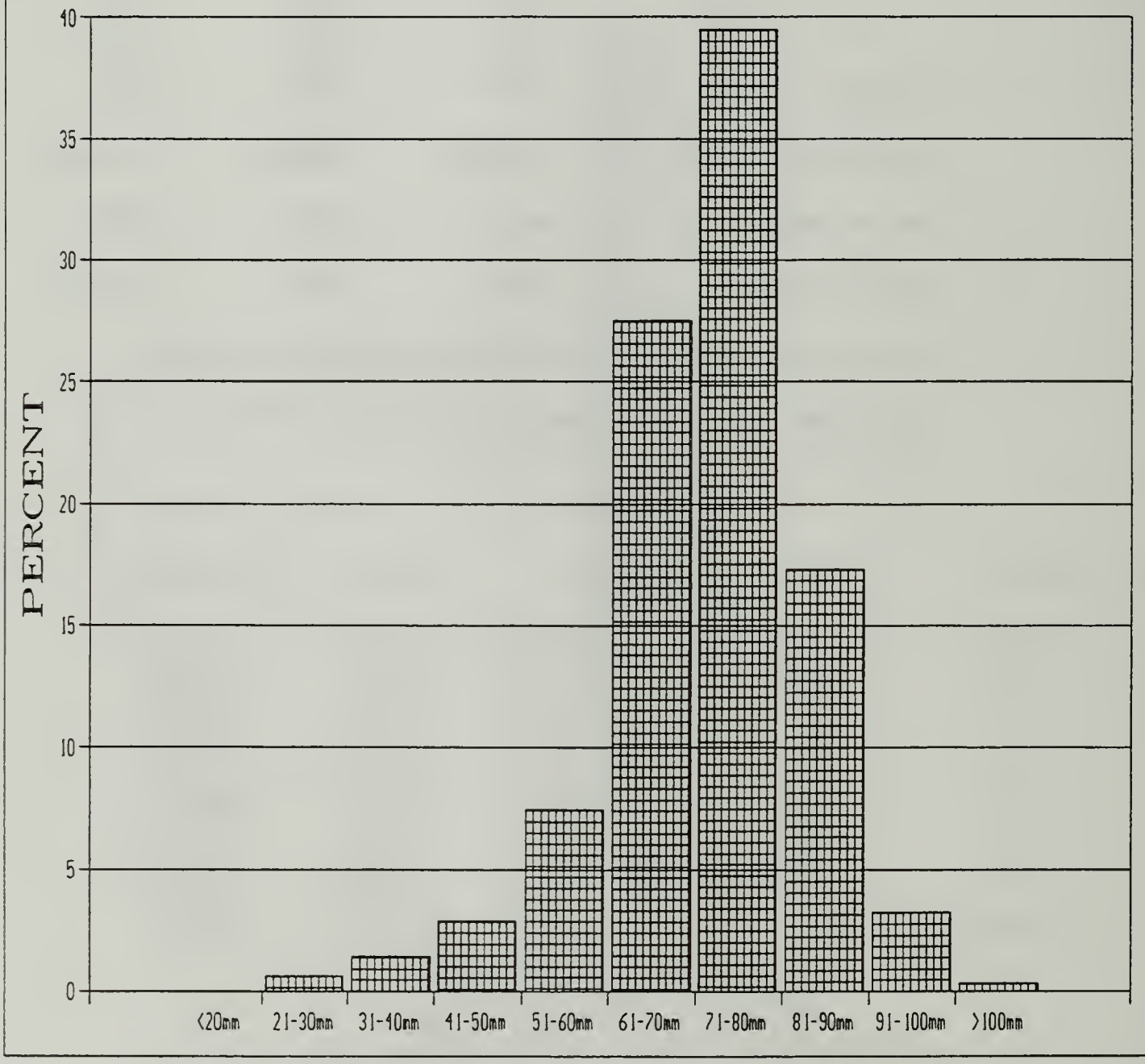
Other Species Noted: Many soft shelled clams, oysters and razor clams.

BottomType in Subarea: Firm sand with mud along northern shore of subarea. Very soft smelly mud at station 110.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I2	108	1.46%	7.30%	21.90%	69.34%
	110	0.00%	0.00%	0.00%	0.00%
	111	4.55%	4.55%	22.73%	68.18%
	115	2.50%	7.50%	35.63%	54.38%
	116	33.33%	0.00%	0.00%	66.67%
	117	0.00%	0.00%	0.00%	100.00%
	118	0.00%	0.00%	25.00%	75.00%
	Avg. %:	**6.97**	**3.22**	**17.54**	**72.26**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 2; New Bedford Inner Harbor



NEW BEDFORD INNER HARBOR
Subarea I-3

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I3	100	3,094,938	71.05	0.00	0.00	0.70	1.41
	101			0.00	0.70	0.00	0.00
	102			0.00	0.70	0.00	0.00
	103			0.00	0.00	0.70	0.00
	104			2.11	0.70	1.41	7.75
	80			0.00	0.70	0.70	0.70
	82			0.00	0.00	0.70	0.00
	84			5.63	8.45	5.63	3.52
	85			1.41	0.00	0.00	0.00
	85A			2.11	2.11	2.11	2.11
	86			1.41	1.41	1.41	0.00
	87			4.93	13.38	16.20	12.68
	89			0.00	0.00	3.52	4.23
	89A			1.41	0.00	2.11	5.63
	92			0.00	0.00	1.41	11.27
	93			0.70	4.23	12.68	5.63
	94			0.00	2.11	0.70	2.82
	95			0.70	1.41	0.00	2.11
	98			0.00	0.00	0.00	0.00
	99			0.06	0.21	0.49	0.53
Avg./sqft:		**1.02**		**1.81**	**2.52**	**3.02**	
Total/Subarea:		**3,156,837**		**5,601,838**	**7,799,244**	**9,346,713**	
Total Bushels/Subarea:				**13,338**	**32,497**	**77,889**	
Total Bushels/Acre:				**187.72**	**457.38**	**1,096**	

Other Species Noted: Oysters along eastern shore of subarea and north shore of Pope's Island. Soft shelled clams in deeper water from station 103 northward.

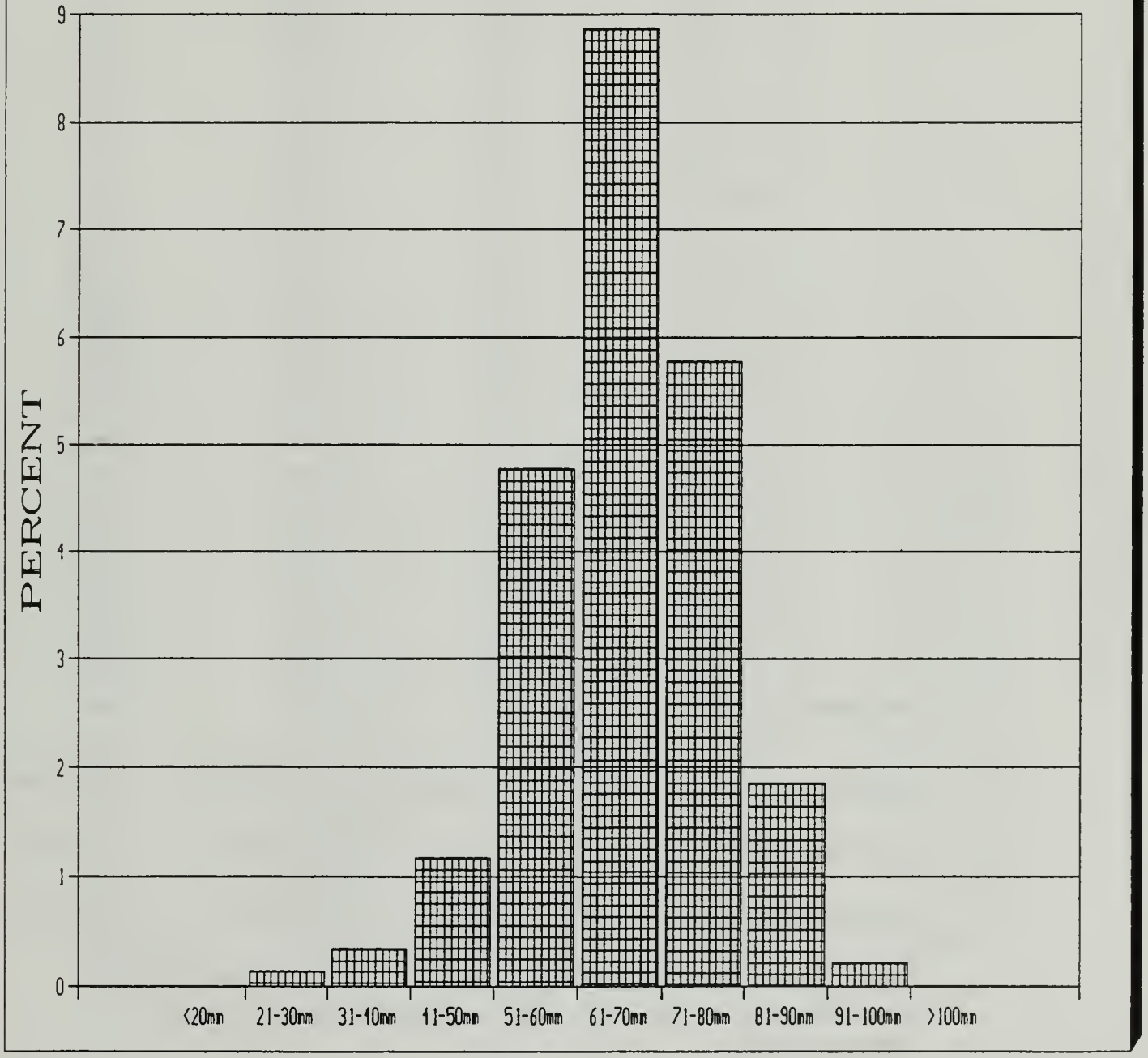
BottomType in Subarea: Thick black mud east end of Pope's Island. Muddy sand with small cobble along north shore of Island (much discarded debris). Firm sand with mud between Island and Brightman Marina. Large mud pocket in center of subarea (stations 93 to 103).

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-3	100	0.00%	0.00%	33.33%	66.67%
	101	0.00%	100.00%	0.00%	0.00%
	102	0.00%	100.00%	0.00%	0.00%
	103	0.00%	0.00%	100.00%	0.00%
	104	17.65%	5.88%	11.76%	64.71%
	80	0.00%	33.33%	33.33%	33.33%
	82	0.00%	0.00%	100.00%	0.00%
	84	24.24%	36.36%	24.24%	15.15%
	85	100.00%	0.00%	0.00%	0.00%
	85A	25.00%	25.00%	25.00%	25.00%
	86	33.33%	33.33%	33.33%	0.00%
	87	10.45%	28.36%	34.33%	26.87%
	89	0.00%	0.00%	45.45%	54.55%
	89A	15.38%	0.00%	23.08%	61.54%
	92	0.00%	0.00%	11.11%	88.89%
	93	3.03%	18.18%	54.55%	24.24%
	94	0.00%	37.50%	12.50%	50.00%
	95	16.67%	33.33%	0.00%	50.00%
	98	0.00%	0.00%	0.00%	0.00%
	99	4.58%	16.03%	38.17%	41.22%
	Avg. %;	**13.18**	**24.60**	**30.54**	**31.69**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 3; New Bedford Inner Harbor



NEW BEDFORD INNER HARBOR
Subarea I-4

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I4	54	2,715,966	62.35	0.04	0.10	0.16	0.14
	55			0.11	0.15	0.19	0.16
	56			0.07	0.20	0.28	0.24
	57			0.29	0.23	0.14	0.04
	61			0.08	0.23	0.44	0.48
	62			0.04	0.05	0.04	0.09
	63			0.00	0.00	0.00	0.00
	64			6.34	3.52	1.41	9.15
	64A			10.00	0.00	10.00	4.71
	64B			1.54	1.54	3.09	5.66
	65A			3.60	3.09	1.03	2.06
	65B			1.54	0.51	2.57	2.57
	66			0.06	0.16	0.42	0.54
	69			0.12	0.12	0.14	0.08
	70			1.10	0.85	1.27	0.49
	71			0.00	1.41	0.70	0.00
	71C			0.51	0.51	2.06	7.21
	71D			0.51	0.00	1.54	1.03
	72			0.00	0.00	2.82	2.82
	73B			2.57	2.57	0.00	18.02
	74A			2.06	3.09	2.57	4.12
	75A			11.33	.78	2.06	9.27
	77			0.00	0.00	1.41	9.15
	77A			12.87	8.24	4.12	4.12
	Avg./sqft:			**2.28**	**1.52**	**1.60**	**3.42**
	Total/Subarea:			**6,192,402**	**4,128,268**	**4,345,546**	**9,288,604**
	Total Bushels/Subarea:				**9,829**	**18,106**	**77,405**
	Total Bushels/Acre:				**157.65**	**290.4**	**1,241.46**

Other Species Noted: Many oysters around Crow's Island. Some soft shelled clams along eastern shore. Few mantis shrimp. Oil sheen on quahogs at stations 54 and 57.

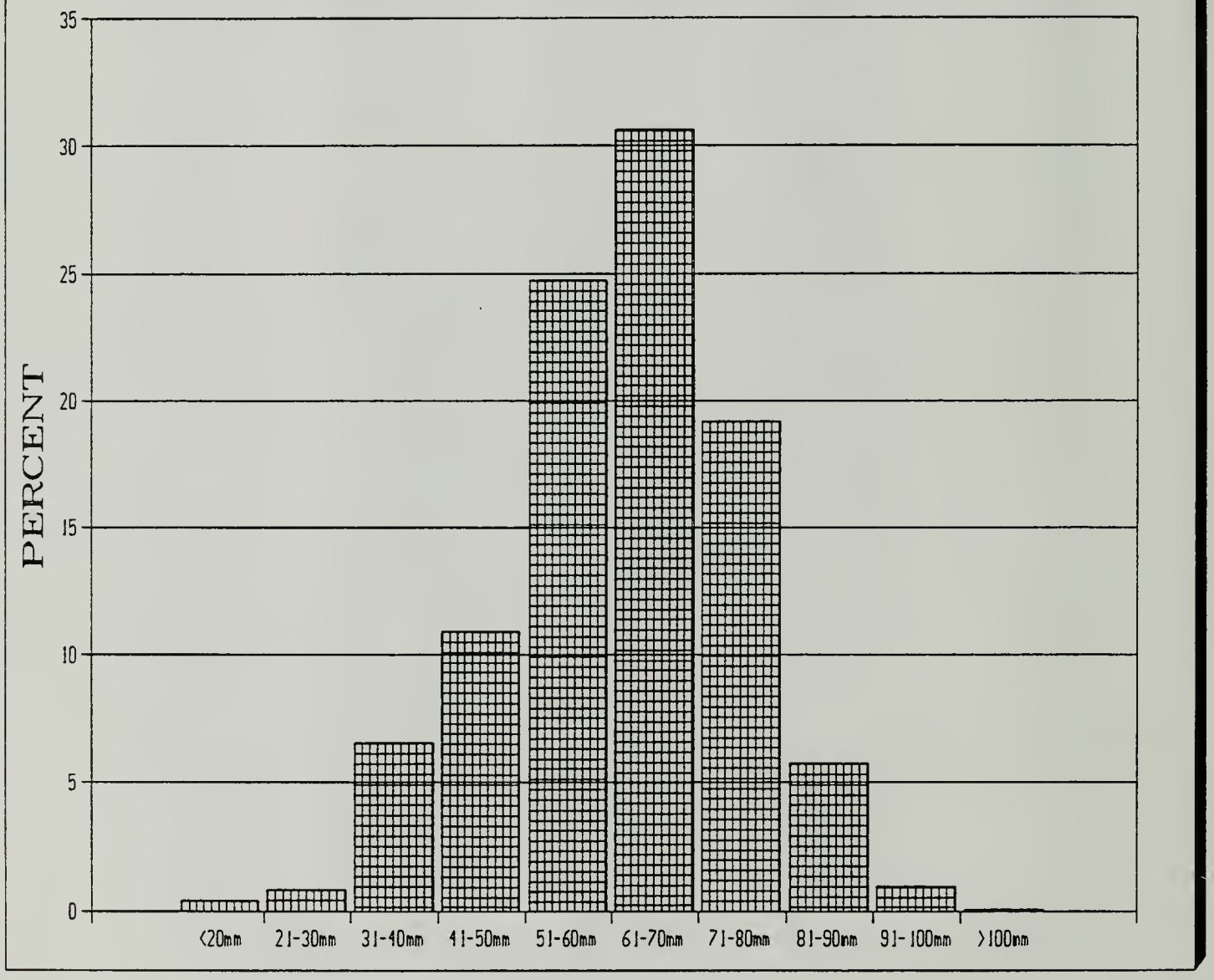
BottomType in Subarea: Relatively firm muddy sand closer to channel. Firm sandy mud east and north of Crow's Island. Smelly mud with sand at station 62.

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-4	54	8.42%	22.63%	36.32%	32.63%
	55	17.71%	25.00%	30.73%	26.56%
	56	8.76%	25.35%	35.48%	30.41%
	57	41.71%	33.16%	19.69%	5.44%
	61	6.67%	18.79%	35.76%	38.79%
	62	19.77%	21.51%	16.86%	41.86%
	63	0.00%	0.00%	0.00%	0.00%
	64	31.03%	17.24%	6.90%	44.83%
	64A	40.48%	0.00%	40.48%	19.05%
	64B	13.04%	13.04%	26.09%	47.83%
	65A	36.84%	31.58%	10.53%	21.05%
	65B	21.43%	7.14%	35.71%	35.71%
	66	4.84%	13.98%	35.48%	45.70%
	69	26.09%	26.09%	30.43%	17.39%
	70	29.76%	22.93%	34.15%	13.17%
	71	0.00%	66.67%	33.33%	0.00%
	71C	5.00%	5.00%	20.00%	70.00%
	71D	16.67%	0.00%	50.00%	33.33%
	72	0.00%	0.00%	50.00%	50.00%
	73B	11.11%	11.11%	0.00%	77.78%
	74A	17.39%	26.09%	21.74%	34.78%
	75A	34.92%	30.16%	6.35%	28.57%
	77	0.00%	0.00%	13.33%	86.67%
	77A	43.86%	28.07%	14.04%	14.04%
	Avg. %:	**18.93**	**19.37**	**26.23**	**35.46**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 4; New Bedford Inner Harbor



NEW BEDFORD INNER HARBOR
Subarea I-5

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I5	25	2,905,452	66.7	0.13	0.45	0.59	0.09
	30			0.04	0.07	0.09	0.02
	31			0.07	0.22	0.40	0.17
	32			0.01	0.03	0.04	0.03
	33			0.00	0.00	0.00	0.00
	41			0.22	0.52	0.78	0.50
	43			0.02	0.07	0.02	0.03
	49			0.04	0.29	0.31	0.12
	51A			0.37	1.12	0.65	0.17
	52			0.00	0.03	0.05	0.02
	53			0.00	0.00	0.00	0.00
			Avg./sqft:	**0.08**	**0.25**	**0.27**	**0.10**
			Total/Subarea:	**232436**	**726,363**	**784,472**	**290,545**
			Total Bushels/Subarea:		**1,729**	**3,269**	**2,421**
			Total Bushels/Acre:		**25.93**	**49.01**	**36.3**

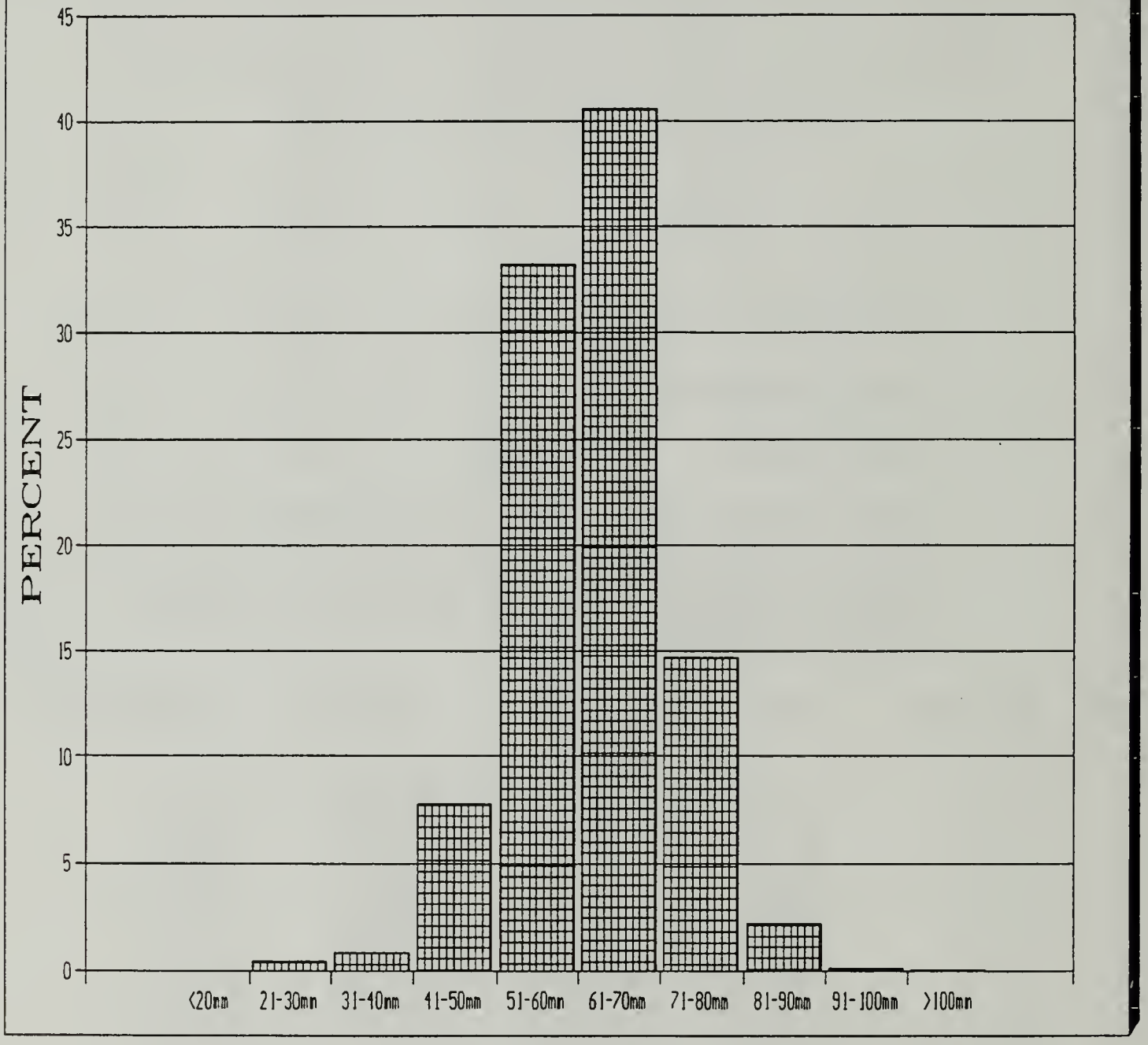
Other Species Noted: Channeled whelk. Knobbed whelk. Starfish. Much ulva.

BottomType in Subarea: Firm mud with sand and medium cobble station 32. Mud with sand at Coal Pocket Pier. Smelly mud at station 52. Otherwise muddy sand with varying sized debris.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-5	25	10.50%	35.71%	46.64%	7.14%
	30	16.67%	33.33%	41.67%	8.33%
	31	7.84%	25.49%	47.06%	19.61%
	32	7.14%	25.00%	39.29%	28.57%
	33	0.00%	0.00%	0.00%	0.00%
	41	10.75%	25.70%	38.79%	24.77%
	43	12.50%	50.00%	12.50%	25.00%
	49	5.83%	38.12%	40.81%	15.25%
	51A	16.01%	48.40%	28.11%	7.47%
	52	1.79%	26.79%	55.36%	16.07%
	53	0.00%	0.00%	0.00%	0.00%
	Avg. %:	**9.89**	**34.28**	**38.91**	**16.91**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 5; New Bedford Inner Harbor



NEW BEDFORD INNER HARBOR
Subarea I-6

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I6	26	1,894,860	43.5	0.11	0.31	0.49	0.49
	28			0.11	0.23	0.31	0.28
	29			0.04	0.21	0.51	0.46
	34			0.07	0.39	0.61	0.32
	35			0.18	0.38	0.74	0.53
	36			1.03	0.51	1.03	2.06
	36A			0.00	0.00	0.00	0.00
	37			0.01	0.04	0.14	0.15
	38			0.04	0.29	0.78	0.44
	45			0.08	0.27	0.88	0.48
	46			0.20	0.27	0.50	0.27
	46A			3.09	3.60	3.60	18.02
	46B			0.00	0.00	0.00	0.00
	46C			2.60	1.73	1.30	2.60
	46D			9.78	7.72	4.12	5.15
	46E			1.78	0.89	2.67	4.45
	46F			0.00	0.51	4.12	0.51
	47			1.54	1.03	3.60	7.21
	47A			1.03	0.00	1.54	2.57
	47B			1.12	0.75	0.37	1.87
	48			0.09	0.16	0.29	0.23
	Avg./sqft:			**1.09**	**0.92**	**1.31**	**2.29**
	Total/Subarea:			**2065397**	**1,743,271**	**2,482,267**	**4,339,229**
	Total Bushels/Subarea:				**4,150**	**10,343**	**36,160**
	Total Bushels/Acre:				**95.42**	**237.77**	**831.27**

Other Species Noted: Much Crepidula. Many starfish. Many oysters stations 46 to 48. Channeled whelk. Knobbed whelk. Spider crab. Lady Crab. Blue crab. Oil sheen on quahogs at stations 28 and 34.

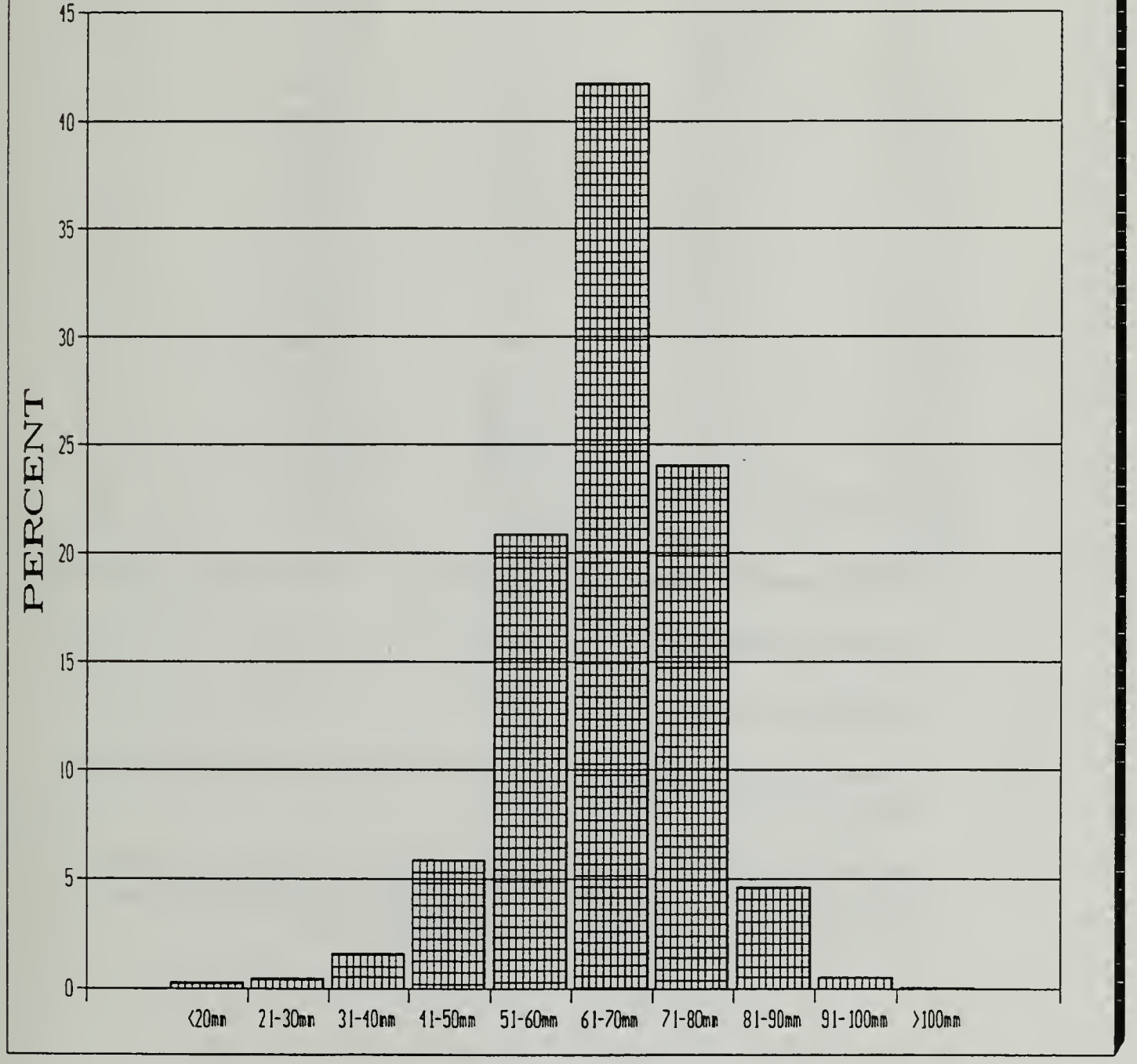
BottomType in Subarea: Firm sandy mud throughout most of subarea. Soft mud among piers. Soft sandy mud with odor near Fairhaven Sewer outfall. Firm sand with mud between stations 36 and 47A.

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-6	26	8.06%	22.04%	34.95%	34.95%
	28	11.98%	24.42%	33.18%	30.41%
	29	3.35%	17.32%	41.90%	37.43%
	34	5.13%	27.69%	44.10%	23.08%
	35	9.64%	20.81%	40.61%	28.93%
	36	22.22%	11.11%	22.22%	44.44%
	36A	0.00%	0.00%	0.00%	0.00%
	37	3.90%	10.39%	42.21%	43.51%
	38	2.46%	18.72%	50.25%	28.57%
	45	4.50%	15.77%	51.80%	27.93%
	46	15.77%	22.07%	40.09%	22.07%
	46A	10.91%	12.73%	12.73%	63.64%
	46B	0.00%	0.00%	0.00%	0.00%
	46C	31.58%	21.05%	15.79%	31.58%
	46D	36.54%	28.85%	15.38%	19.23%
	46E	18.18%	9.09%	27.27%	45.45%
	46F	0.00%	10.00%	80.00%	10.00%
	47	11.54%	7.69%	26.92%	53.85%
	47A	20.00%	0.00%	30.00%	50.00%
	47B	27.27%	18.18%	9.09%	45.45%
	48	12.09%	20.47%	37.21%	30.23%
	Avg. %:	**13.43**	**16.76**	**34.51**	**35.30**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 6; New Bedford Inner Harbor



QUAHOG STANDING CROP ASSESSMENT
NEW BEDFORD INNER HARBOR
Subarea I-7A

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I7A	1	1,579,050	36.25	0.15	0.36	0.41	1.49
	12			0.00	0.08	0.13	0.02
	13			0.00	0.03	0.04	0.02
	14			0.12	0.32	0.73	0.68
	1A			0.00	2.11	1.41	1.41
	1B			0.00	0.00	0.70	0.00
	1C			0.00	0.00	0.70	2.11
	1D			0.00	0.70	0.70	0.70
	1E			0.00	0.00	0.00	0.00
	1F			0.00	0.70	0.70	0.00
	1G			0.00	0.00	0.00	0.00
	2			0.00	0.00	0.83	0.41
	3			0.11	0.67	0.64	0.17
	5			0.05	0.42	0.47	0.18
	X			2.82	2.82	0.00	0.00
	Y			0.00	0.00	1.41	3.52
	Z			1.41	2.82	6.34	2.82
			Avg./sqft:	**0.27**	**0.65**	**0.90**	**0.80**
Total/Subarea:		**426,344**		**1,026,383**		**1,421,145**	**1,263,240**
Total Bushels/Subarea:				**2,444**		**5,921**	**10,527**
Total Bushels/Acre:				**67.41**		**163.35**	**290.4**

Other Species Noted: Many oysters. Some Crepidula. Many soft shelled clams along western shore of subarea. Much ulva.

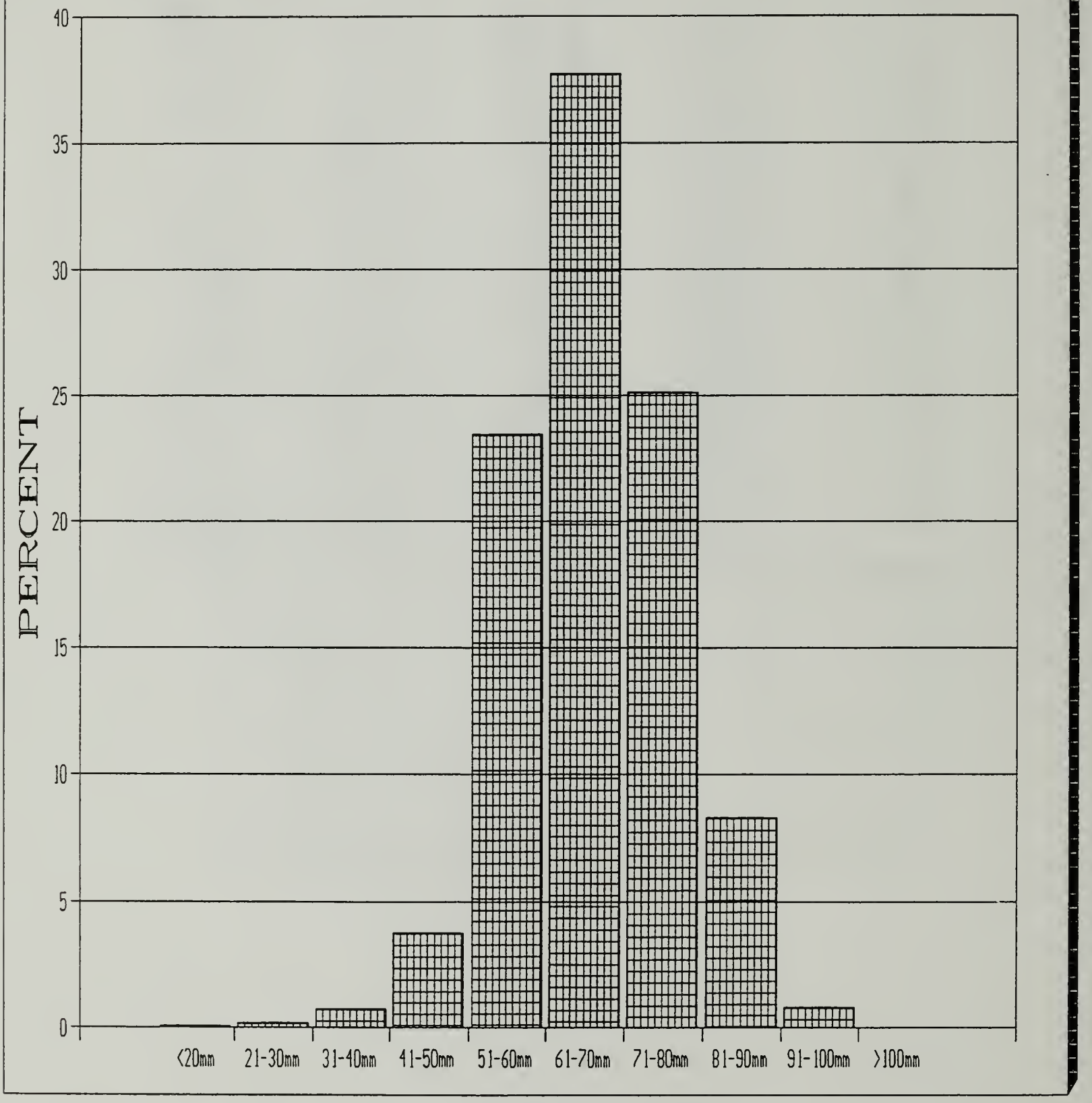
BottomType in Subarea: Black mud with strong odor proximal to hurricane barrier. Sandy mud along western shoreline. Sandy mud with odor at station 12. Firm sand with mud and small cobble around station 3.

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-7A	1	6.22%	15.03%	17.10%	61.66%
	12	0.00%	35.71%	57.14%	7.14%
	13	1.11%	27.78%	47.78%	23.33%
	14	6.25%	17.19%	39.58%	36.98%
	1A	0.00%	42.86%	28.57%	28.57%
	1B	0.00%	0.00%	100.00%	0.00%
	1C	0.00%	0.00%	25.00%	75.00%
	1D	0.00%	33.33%	33.33%	33.33%
	1E	0.00%	0.00%	0.00%	0.00%
	1F	0.00%	50.00%	50.00%	0.00%
	1G	0.00%	0.00	0.00%	0.00%
	2	0.00%	0.00%	66.67%	33.33%
	3	6.77%	42.23%	40.24%	10.76%
	5	4.46%	37.50%	41.96%	16.07%
	X	50.00%	50.00%	0.00%	0.00%
	Y	0.00%	0.00%	28.57%	71.43%
	Z	10.53%	21.05%	47.37%	21.05%
Avg. %:		**5.69**	**24.85**	**41.55**	**27.91**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 7A; New Bedford Inner Harbor



NEW BEDFORD INNER HARBOR
Subarea I-7B

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I7B	11B	568,458	13.05	1.41	3.52	9.86	11.97
	11C			2.11	8.45	4.93	4.93
	11C			1.41	3.52	9.15	9.15
	15			0.14	0.45	0.36	0.05
	15B			0.00	2.11	10.56	13.38
	15C			0.00	0.00	1.41	4.23
	15D			2.11	0.70	4.23	17.61
	20			0.08	0.32	0.64	0.38
	2C			0.70	10.56	8.45	1.41
	2D			6.34	4.23	7.04	13.38
	2E			4.93	7.04	11.27	9.86
	2F			0.00	3.52	1.41	7.04
	2G			0.70	2.11	10.56	10.56
	2H			0.00	0.00	2.82	2.82
	2I			1.41	2.82	4.23	9.15
	4			0.06	0.17	0.35	0.30
	4A			1.41	2.82	0.70	0.70
	4C			5.35	1.78	14.27	5.35
	4D			0.00	5.63	17.61	16.20
	4E			0.00	0.70	2.11	2.11
	5A			4.93	14.08	5.63	4.23
	5B			2.11	21.13	7.75	7.04
	5C			2.11	0.70	4.23	0.00
	Avg./sqft:			**1.62**	**4.19**	**6.07**	**6.60**
	Total/Subarea:			**920,902**	**2,381,839**	**3,450,540**	**3,751,823**
	Total Bushels/Subarea:				**5,671**	**14,377**	**31,265**
	Total Bushels/Acre:				**434.56**	**1,101.71**	**2,395.8**

Other Species Noted: Many oysters along hurricane barrier and Palmer's Island. Many soft shelled clams at southern end of Palmer's Island and some up western shoreline of island. Much Crepidula in deeper water. Oil sheen on quahogs at station 20.

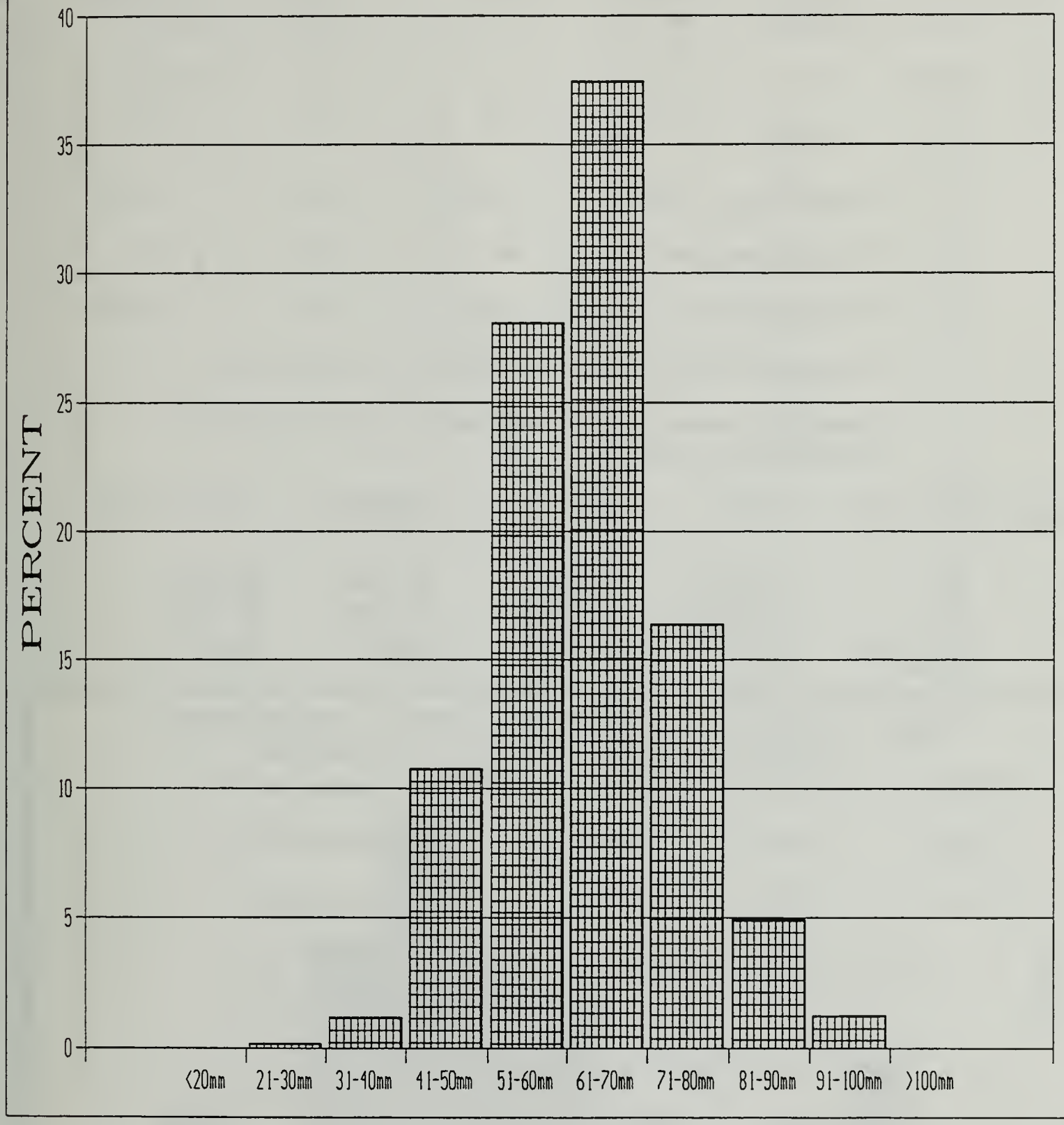
BottomType in Subarea: Gravelly sand with some mud along western shore of Palmer's Island. Muddy sand with small gravel at southern tip. Sandy mud at station 24.

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-7B	11B	5.26%	13.16%	36.84%	44.74%
	11C	10.34%	41.38%	24.14%	24.14%
	11C	6.06%	15.15%	39.39%	39.39%
	15	13.89%	44.91%	36.11%	5.09%
	15B	0.00%	8.11%	40.54%	51.35%
	15C	0.00%	0.00%	25.00%	75.00%
	15D	8.57%	2.86%	17.14%	71.43%
	20	5.45%	22.77%	45.05%	26.73%
	2C	3.33%	50.00%	40.00%	6.67%
	2D	20.45%	13.64%	22.73%	43.18%
	2E	14.89%	21.28%	34.04%	29.79%
	2F	0.00%	29.41%	11.76%	58.82%
	2G	2.94%	8.82%	44.12%	44.12%
	2H	0.00%	0.00%	50.00%	50.00%
	2I	8.00%	16.00%	24.00%	52.00%
	4	6.58%	19.30%	39.91%	34.21%
	4A	25.00%	50.00%	12.50%	12.50%
	4C	20.00%	6.67%	53.33%	20.00%
	4D	0.00%	14.29%	44.64%	41.07%
	4E	0.00%	14.29%	42.86%	42.86%
	5A	17.07%	48.78%	19.51%	14.63%
	5B	5.56%	55.56%	20.37%	18.52%
	5C	30.00%	10.00%	60.00%	0.00%
	Avg. %:	**8.84**	**22.02**	**34.09**	**35.05**

SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

Subarea 7B; New Bedford Inner Harbor



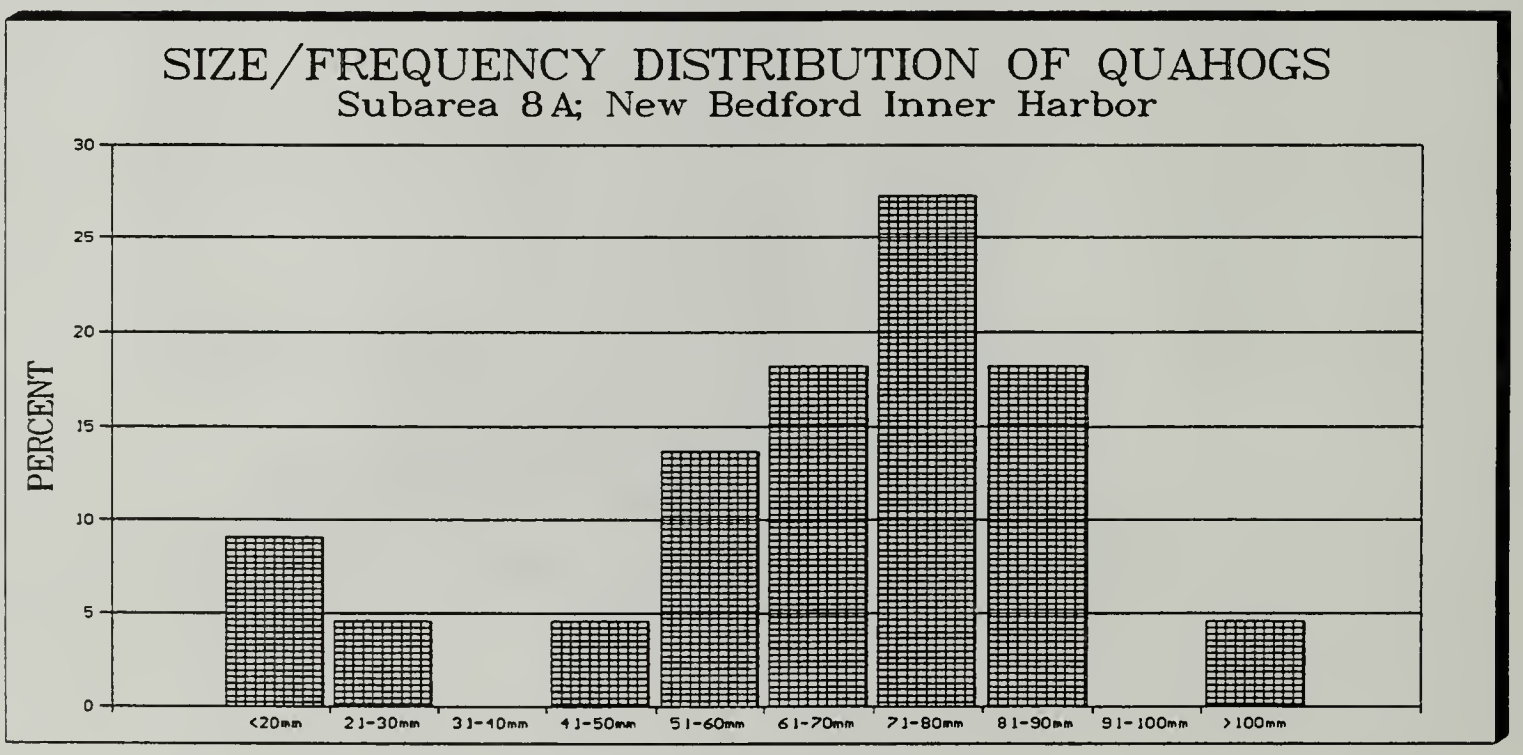
NEW BEDFORD INNER HARBOR
Subarea I-8A

Sub Area	Sta #	SqFt/ Subarea	Acres/ Subarea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I8A	6	378,972	8.7	0.00	0.00	0.51	2.06
	10			2.06	1.54	1.54	3.60
			Avg./sqft:	**1.03**	**0.77**	**1.03**	**2.83**
			Total/Subarea:	**390,341**	**291,808**	**390,341**	**1,072,491**
			Total Bushels/Subarea:		**695**	**1,626**	**8,937**
			Total Bushels/Acre:		**79.86**	**186.95**	**1,027.29**

Other Species Noted: Some Crepidula. Ribbon worm. Knobbed whelk.

BottomType in Subarea: Firm gravelly sand at station 10. Sandy mud with much shell shack at station 6.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-8A	6	0.00%	0.00%	20.00%	80.00%
	10	23.53%	17.65%	17.65%	41.18%
	Avg. %:	**11.76**	**8.82**	**18.82**	**60.59**



NEW BEDFORD INNER HARBOR
Subarea I-8B

Sub Area	Sta #	SqFt/ Subarea	Acres/ SubaArea	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
I8B	10A	1,263,240	29	4.63	6.69	7.21	14.42
	10B			0.51	1.03	2.57	6.69
	10C			0.00	1.54	1.03	4.63
	10D			0.00	0.00	2.06	13.39
	10E			1.54	6.18	5.15	3.09
	10F			0.00	0.51	0.51	12.87
	10G			6.69	1.54	1.03	7.21
	10H			0.00	0.88	0.00	0.15
	16			0.36	0.28	0.27	0.26
	17			0.00	0.00	3.60	4.63
	17B			1.51	2.51	6.03	11.57
	18			6.69	7.21	7.21	9.27
	18A			4.47	3.35	6.70	11.73
	18B			0.51	1.54	4.12	6.18
	18C			1.54	0.51	2.57	2.06
	18D			4.12	6.18	13.39	14.93
	18E			1.03	0.00	6.18	10.30
	19			0.07	0.15	0.32	0.22
	27			0.51	0.51	3.09	4.63
	27A			0.00	0.00	0.00	0.00
	8			0.00	0.07	0.11	0.04
	9			0.29	0.41	0.42	0.43
	CX			0.00	0.00	0.51	4.63
		Avg./sqft:		**1.50**	**1.79**	**3.22**	**6.23**
		Total/Subarea:	**1,894,860**	**2,261,200**	**4,067,633**	**7,869,985**	
		Total Bushels/Subarea:		**5,384**	**16,948**	**65,583**	
		Total Bushels/Acre:		**185.65**	**584.43**	**2,261.49**	

Other Species Noted: Much Crepidula. Spider crab. Green crab. Lady crab. Many knobbed whelk. Many paired soft shelled clam shells. Oil sheen on quahogs at station 16.

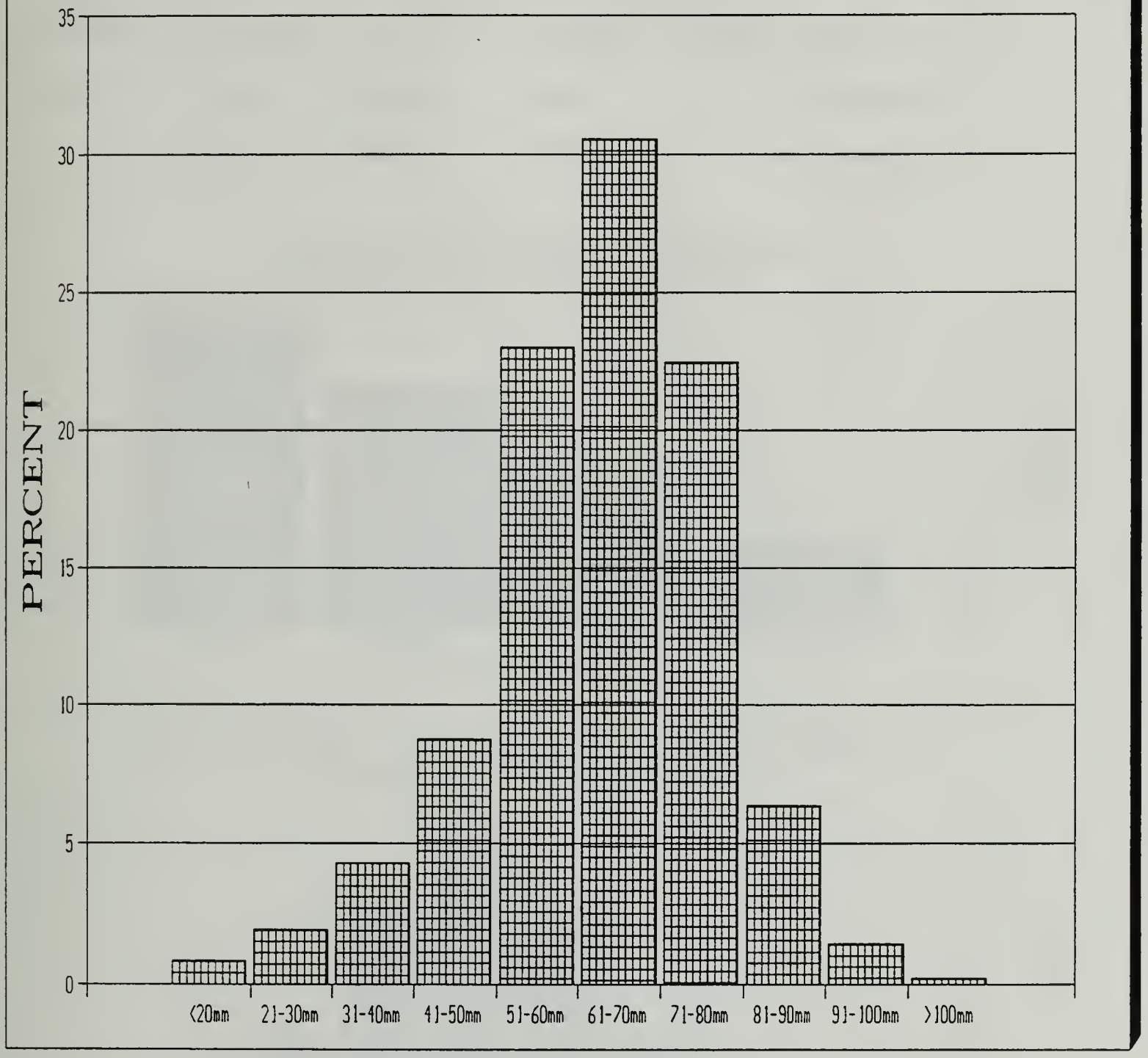
BottomType in Subarea: Soft mud with much small debris proximal to hurricane barrier. Firm gravelly sand stations 10A to 10H. Firm muddy sand at station 19.

PERCENTAGE OF QUAHOGS FOR SIZE CATEGORIES
By Station

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
I-8B	10A	14.06%	20.31%	21.88%	43.75%
	10B	4.76%	9.52%	23.81%	61.90%
	10C	0.00%	21.43%	14.29%	64.29%
	10D	0.00%	0.00%	13.33%	86.67%
	10E	9.68%	38.71%	32.26%	19.35%
	10F	0.00%	3.70%	3.70%	92.59%
	10G	40.63%	9.38%	6.25%	43.75%
	10H	0.00%	85.71%	0.00%	14.29%
	16	31.14%	24.12%	22.81%	21.93%
	17	0.00%	0.00%	43.75%	56.25%
	17B	6.98%	11.63%	27.91%	53.49%
	18	22.03%	23.73%	23.73%	30.51%
	18A	17.02%	12.77%	25.53%	44.68%
	18B	4.17%	12.50%	33.33%	50.00%
	18C	23.08%	7.69%	38.46%	30.77%
	18D	10.67%	16.00%	34.67%	38.67%
	18E	5.88%	0.00%	35.29%	58.82%
	19	9.36%	19.21%	42.36%	29.06%
	27	5.88%	5.88%	35.29%	52.94%
	27A	0.0%%	0.00%	0.00%	0.00%
	8	2.04%	29.25%	50.34%	18.37%
	9	18.64%	26.36%	27.27%	27.73%
	CX	0.00%	0.00%	10.00%	90.00%
	Avg. %:	**10.27**	**17.18**	**25.74**	**46.81**

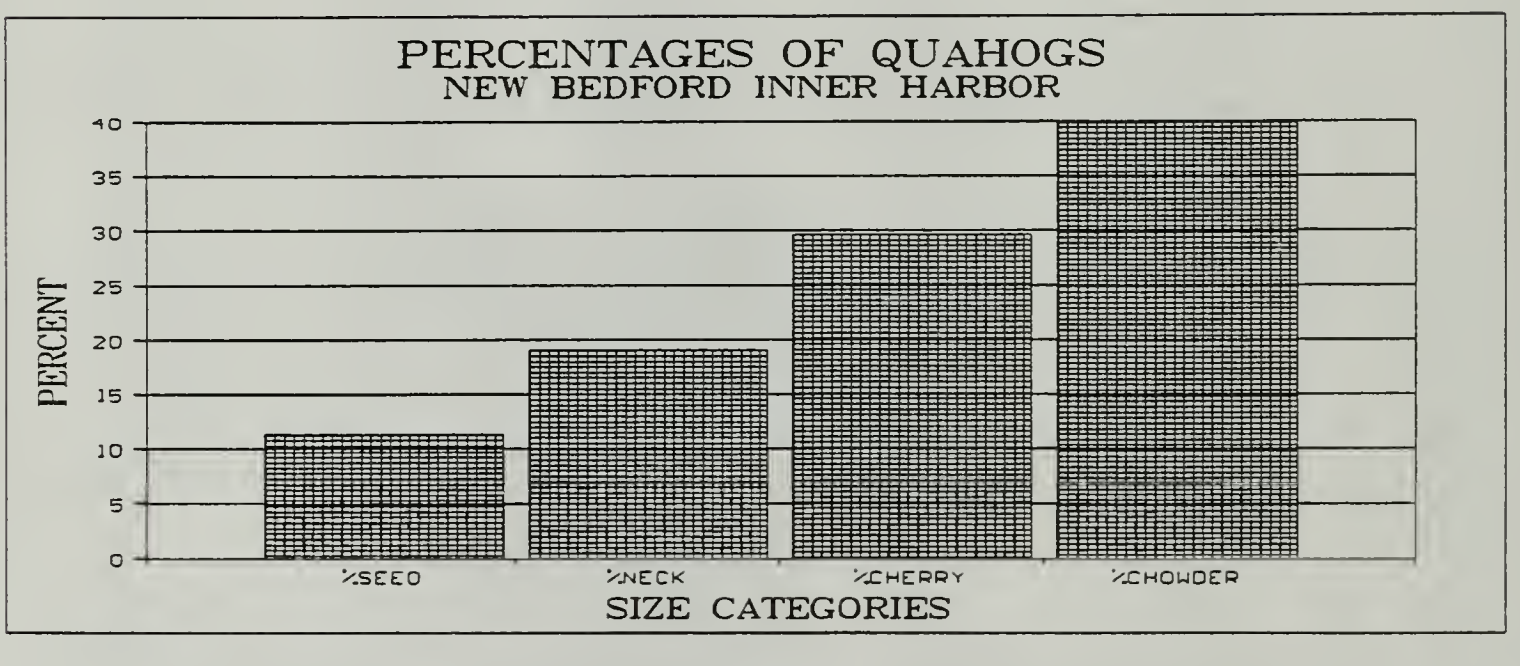
SIZE/FREQUENCY DISTRIBUTION OF QUAHOGS

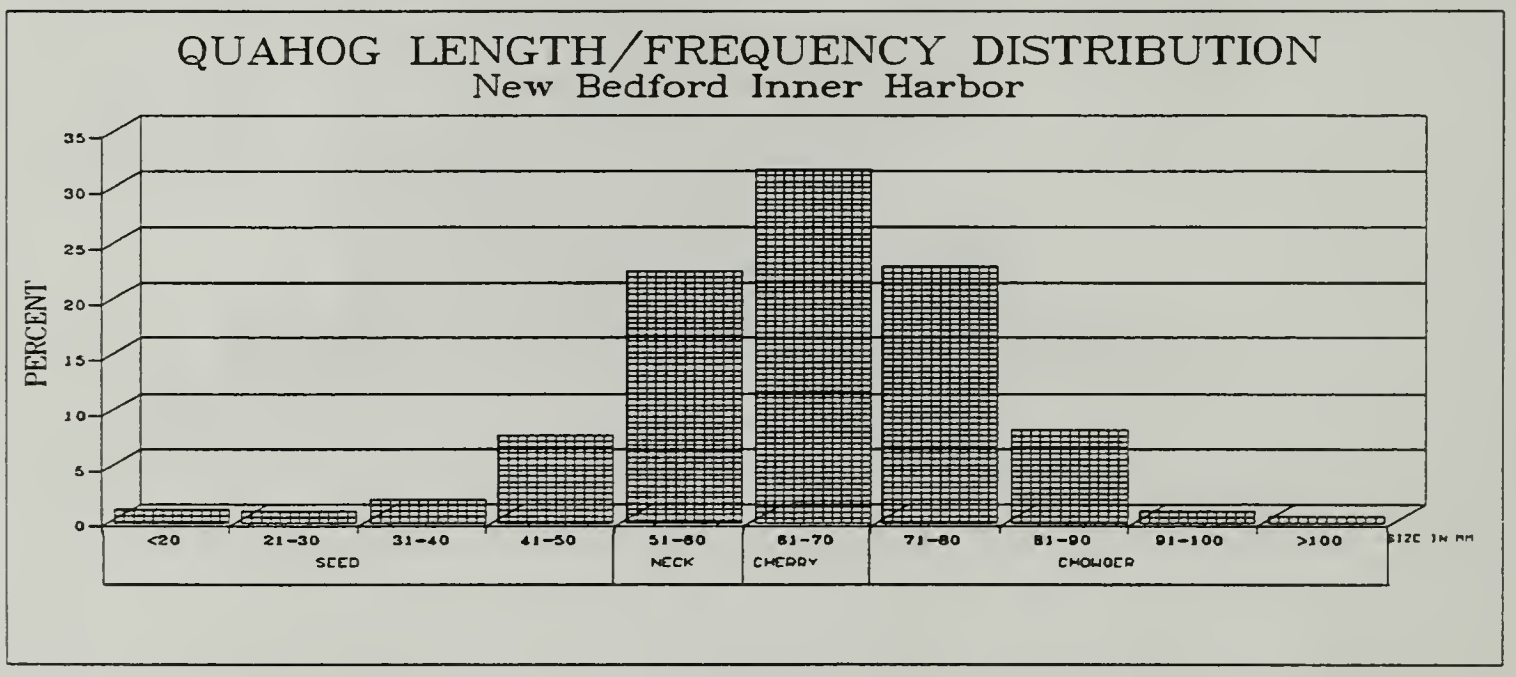
Subarea 8B; New Bedford Inner Harbor



QUAHOG STANDING CROP ASSESSMENT
NEW BEDFORD INNER HARBOR

Area Square Feet	Area Acres					
17,495,874	401.65	**Seed**	**Littleneck**	**Cherrystone**	**Chowder**	**Totals**
	Total Quahogs	**16,680,452**	**21,346,744**	**28,333,211**	**44,534,264**	**110,894,671**
	Total Bushels		**50,826**	**118,055**	**371,119**	**540,000**
	Total Bushels/Acre:		**126.54**	**293.93**	**923.99**	





Appendix C

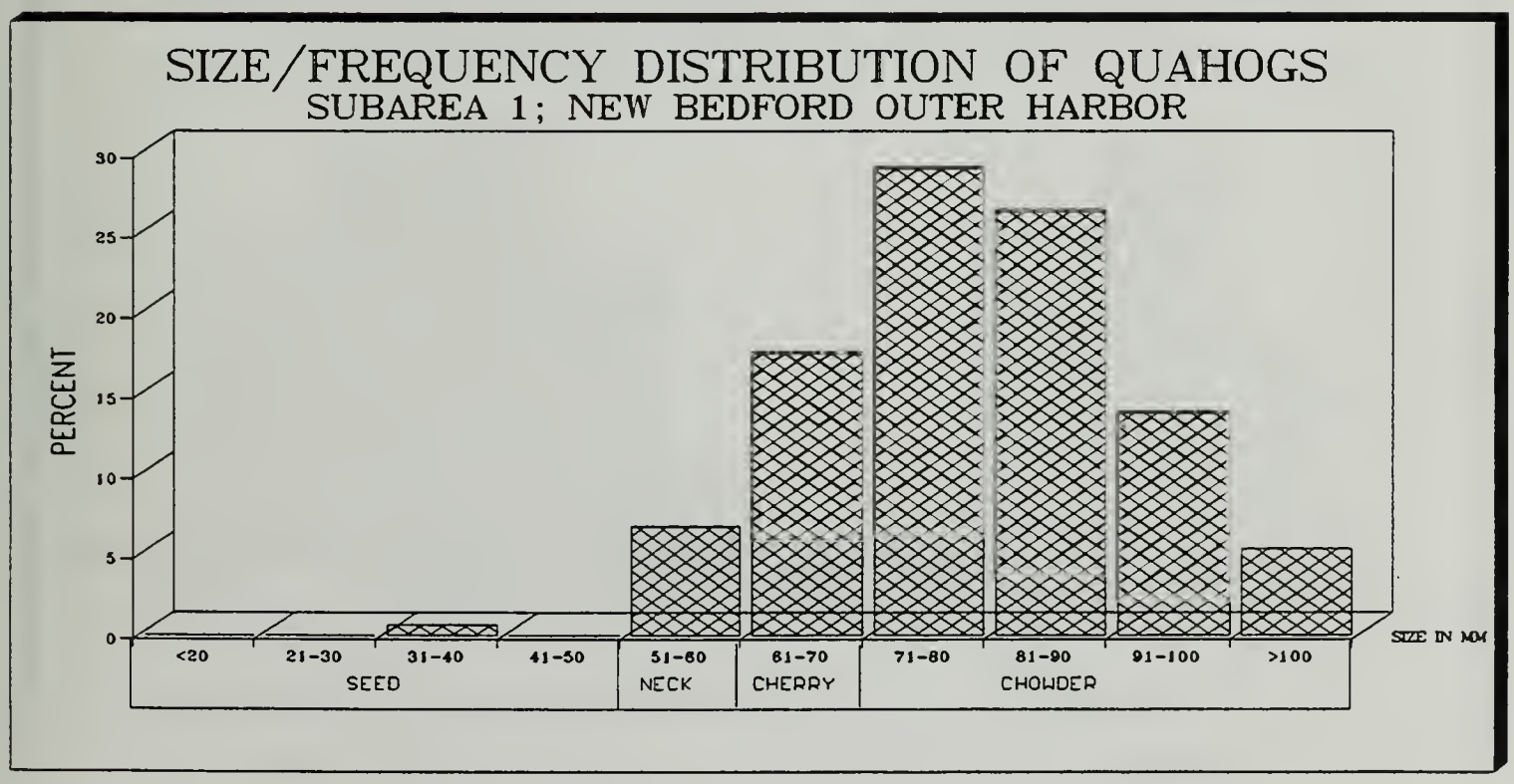
Outer Harbor
Standing Crop Sample Data
Tables and Graphs

NEW BEDFORD OUTER HARBOR
Subarea 1

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
1	1,742,400	40	2	0.000	0.000	0.031	0.503
			1	0.004	0.041	0.094	0.252
		Avg./SqFt:		**0.002**	**0.020**	**0.063**	**0.378**
		Total/Subarea:		**3,569.06**	**34,848**	**109,771**	**658,627**
		Total Bushels/Subarea:			**83**	**457**	**5,489**
		Total Bushels/Acre:			**2.07**	**11.43**	**137.23**

Other Species Noted: Spider, Lady, blue, Green Crabs. Knobbed and Channeled Whelks. 3 Bay Scallops.
Bottom Type Noted: Gravelly sand with some clay.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
1	2	0.00%	0.00%	5.77%	94.23%
	1	1.05%	10.47%	24.08%	64.40%
	Avg. %:	**0.52**	**5.24**	**14.93**	**79.31**



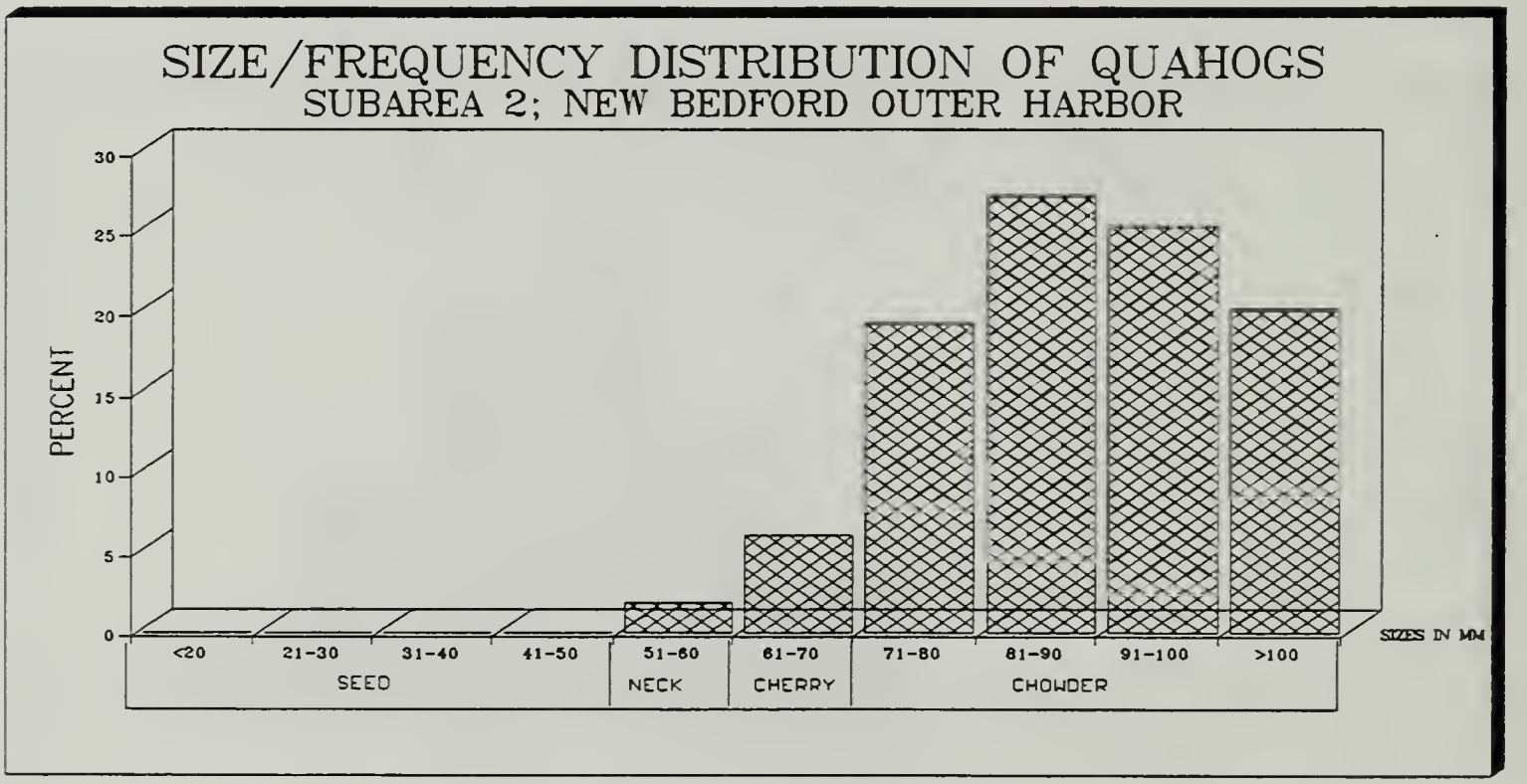
NEW BEDFORD OUTER HARBOR
Subarea 2

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
2	1,960,200	45	3	0.000	0.024	0.072	0.687
			5	0.000	0.000	0.013	1.042
		Avg./SqFt:		**0.000**	**0.012**	**0.042**	**0.864**
		Total/Subarea:		**0.00**	**23,552**	**82,328**	**1,693,613**
		Total Bushels/Subarea:			**56**	**343**	**14,113**
		Total Bushels/Acre:			**1.24**	**7.62**	**313.6**

Other Species Noted: Channeled Whelk. Spider Crab.

Bottom Type Noted: Gravelly sand with some mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
2	3	0.00%	3.05%	9.16%	87.79%
	5	0.00%	0.00%	1.22%	98.78%
	Avg. %:	**0.00**	**1.53**	**5.19**	**93.28**



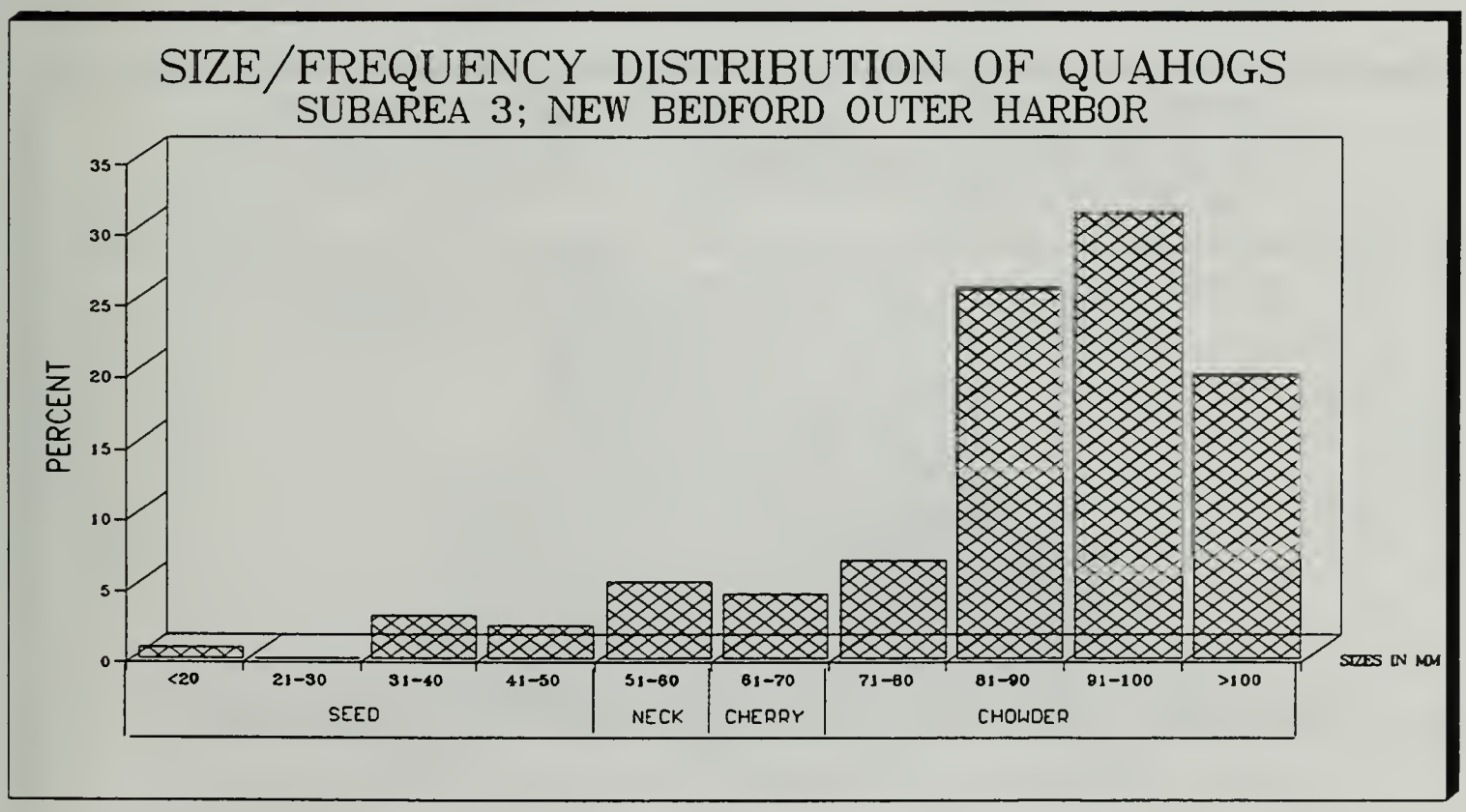
NEW BEDFORD OUTER HARBOR
Subarea 3

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
3	1,306,800	30	7	0.045	0.040	0.034	0.625
		Total/Subarea:		**59,358**	**52,272**	**44,431**	**816,750**
		Total Bushels/Subarea:			**125**	**185**	**6,806**
		Total Bushels/Acre:			**4.15**	**6.17**	**226.9**

Other Species Noted: Oyster. Many Spider Crab. Knobbed, Channeled Whelk. Much Codium.

Bottom Type Noted: Gravelly mud with some sand.

Subarea	Station #:	seed	Neck	Cherry	Chowder
3	7	6.15%	5.38%	4.62%	84.62%
	Avg. %:	**6.15**	**5.38**	**4.62**	**84.62**



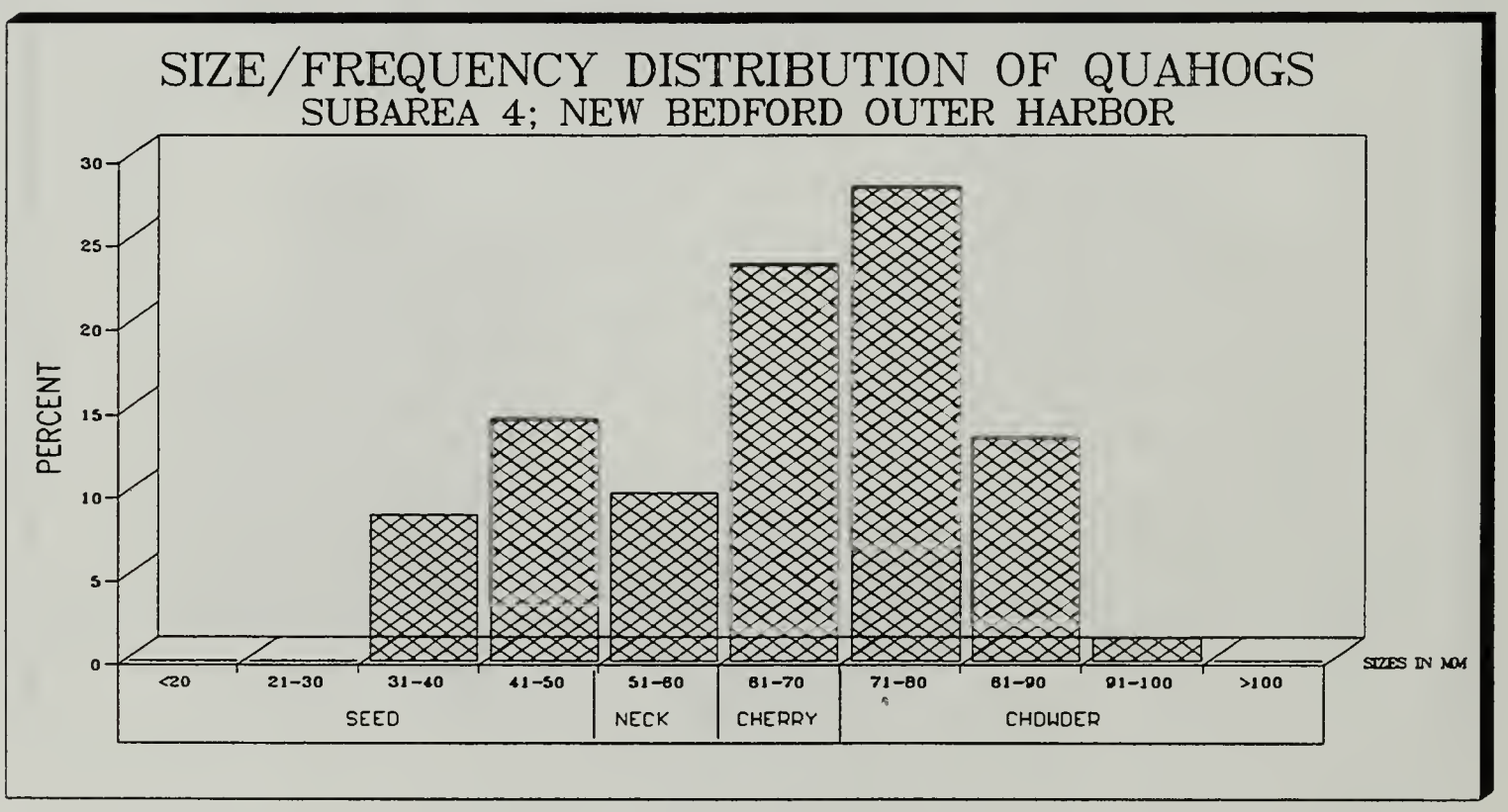
NEW BEDFORD OUTER HARBOR
Subarea 4

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
4	1,742,400	40	23A	0.008	0.023	0.088	0.145
			23	0.193	0.060	0.095	0.193
		Avg./SqFt:		**0.100**	**0.041**	**0.092**	**0.169**
		Total/Subarea:		**174,848**	**71,438**	**160,301**	**294,466**
		Total Bushels/Subarea:			**170**	**668**	**2,454**
		Total Bushels/Acre:			**4.26**	**16.68**	**61.34**

Other Species Noted: Oyster. Much Crepidula (limpet).

Bottom Type Noted: Muddy sand with some gravel.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
4	23A	2.86%	8.57%	33.57%	55.00%
	23	35.70%	11.00%	17.60%	35.70%
	Avg. %:	**19.28**	**9.79**	**2** **5.59**	**45.35**

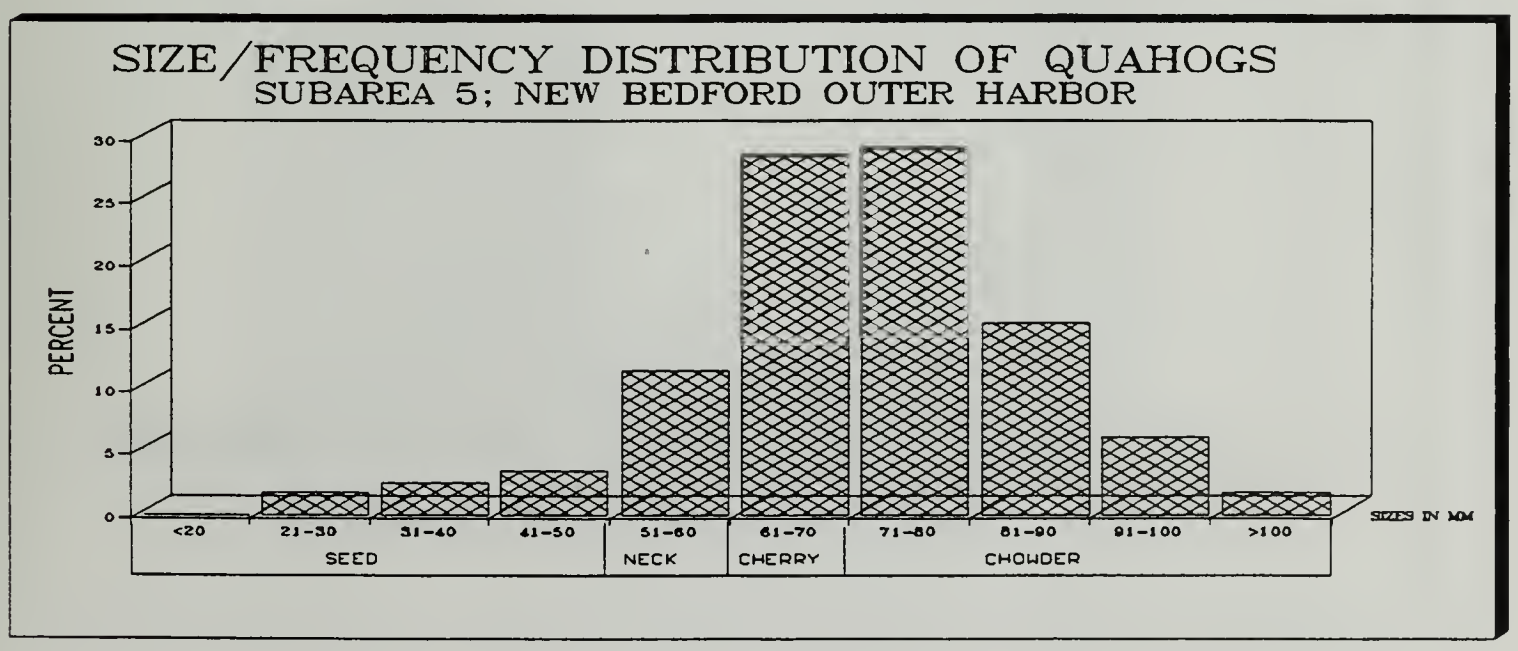


NEW BEDFORD OUTER HARBOR
Subarea 5

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
5	3,876,840	89	10	0.007	0.030	0.068	0.080
			8	0.001	0.003	0.021	0.103
			11	0.000	0.034	0.135	0.789
			25	0.084	0.074	0.158	0.140
		Avg./SqFt:		**0.023**	**0.035**	**0.096**	**0.278**
		Total/Subarea:		**89,748**	**135,689**	**372,177**	**1,077,762**
		Total Bushels/Subarea:			**323**	**1,551**	**8,981**
		Total Bushels/Acre:			**3.63**	**17.4**	**100.91**

Other Species Noted: Oyster. Much Crepidula. Blood Worm. Spider Crab. Codium. Oily sheen on quahogs at station 8.
Bottom Type Noted: Sandy mud with heavy shack (broken shell).

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
5	10	3.73%	16.15%	37.27%	43.48%
	8	1.03%	2.06%	16.49%	80.41%
	11	0.00%	3.49%	13.95%	81.40%
	25	18.39%	16.09%	34.48%	30.46%
Avg. %:		**5.79**	**9.45**	**25.55**	**58.94**



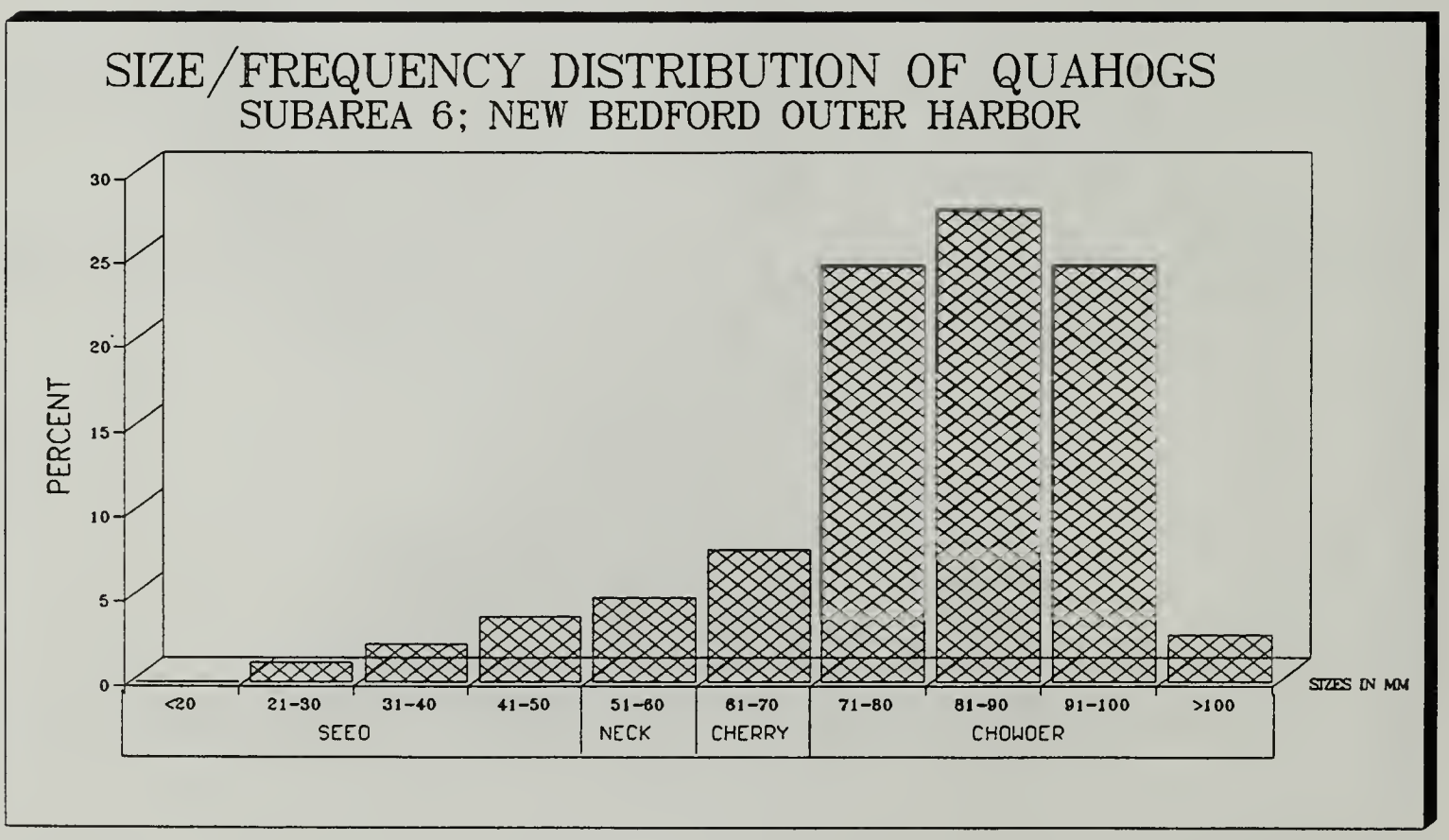
NEW BEDFORD OUTER HARBOR
Subarea 6

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
6	2,526,480	58	27	0.000	0.034	0.053	0.541
		Total/Subarea:		**0.000**	**85,900**	**133,903**	**1,366,826**
		Total Bushels/Subarea:			**205**	**558**	**11,390**
		Total Bushels/Acre:			**3.53**	**9.61**	**196.39**

Other Species Noted: Crepidula. Codium.

Bottom Type Noted: Sandy, gravelly mud with some shack.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
6	27	7.30%	5.02%	7.82%	80.00%
	Avg. %;	**7.3**	**5.02**	**7.82**	**80**



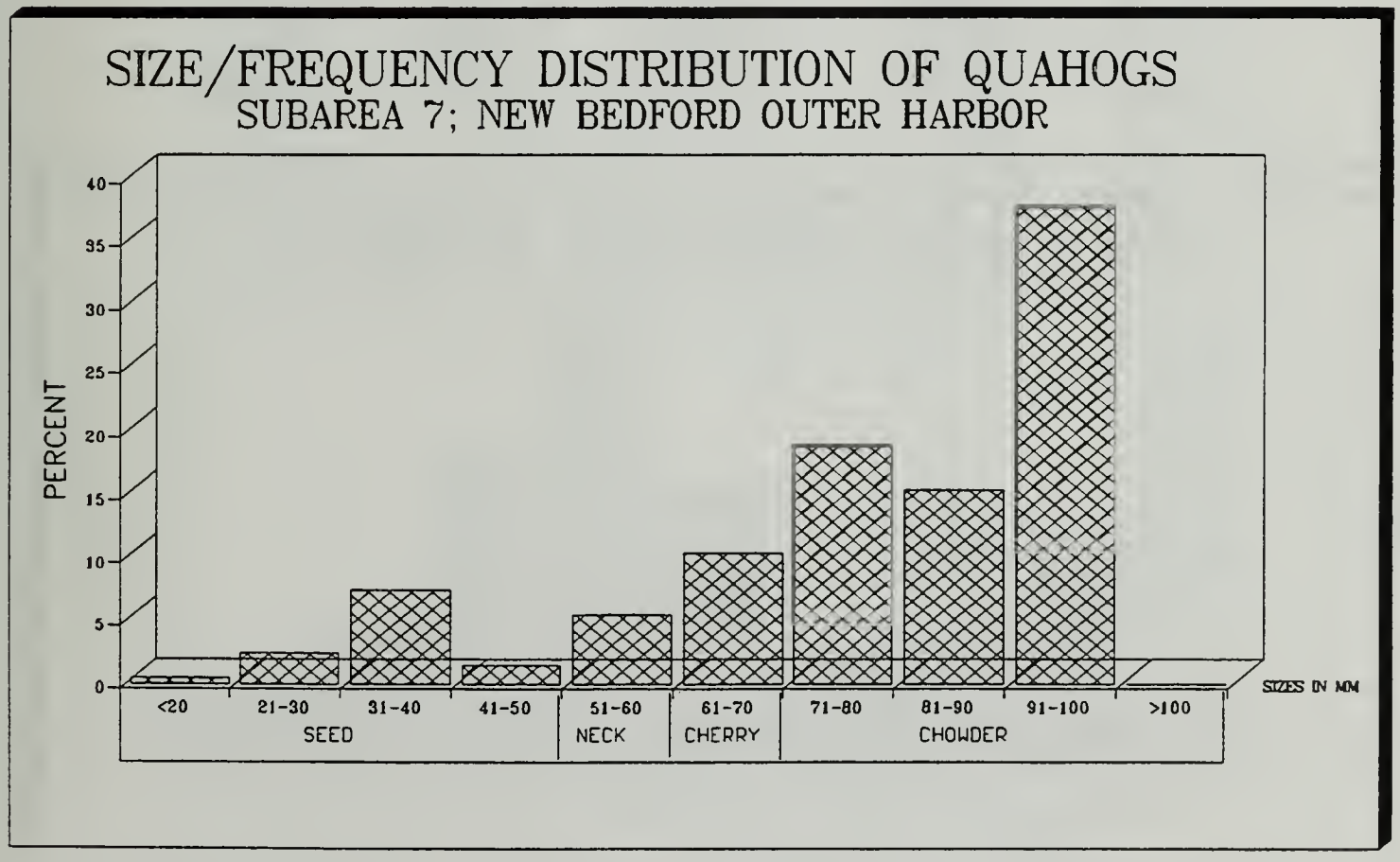
NEW BEDFORD OUTER HARBOR
Subarea 7

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
7	3,005,640	69	31	0.030	0.014	0.026	0.180
			Total/Subarea:	**89,691**	**42,079**	**78,147**	**541,015**
			Total Bushels/Subarea:		**100**	**326**	**4,509**
			Total Bushels/Acre:		**1.45**	**4.71**	**65.53**

Other Species Noted: Channeled Whelk. Much Crepidula. Much Codium.

Bottom Type Noted: Gravelly sand with little mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
7	31	12.00%	5.50%	10.40%	72.14%
	Avg. %:	**12**	**5.5**	**10.4**	**72.14**

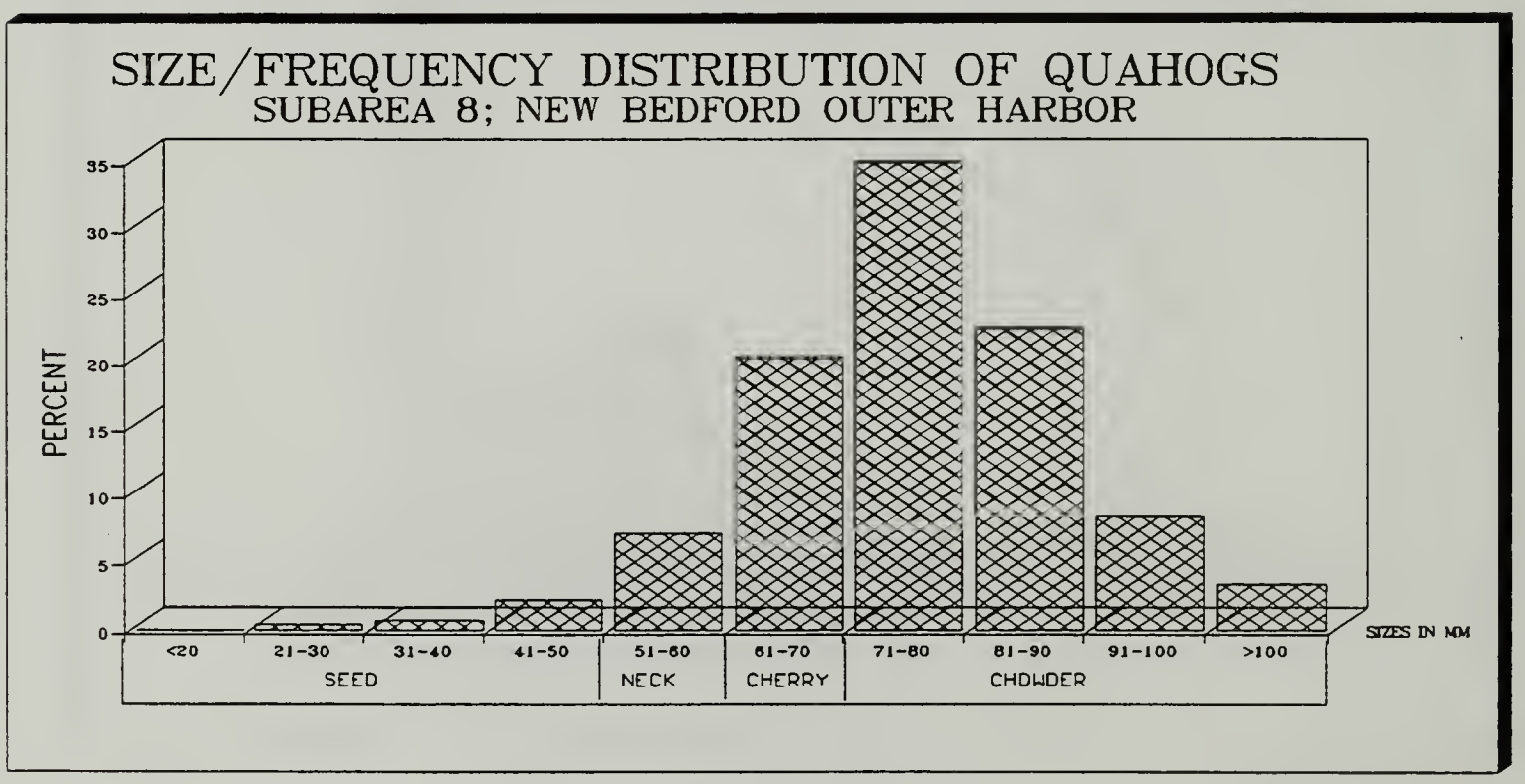


NEW BEDFORD OUTER HARBOR
Subarea 8

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
8	7,274,520	167	33	0.002	0.006	0.020	0.061
			17	0.033	0.111	0.273	0.865
			19	0.004	0.000	0.005	0.039
		Avg./SqFt:		**0.013**	**0.039**	**0.099**	**0.321**
		Total/Subarea:		**92,986**	**283,706**	**720,178**	**2,335,121**
		Total Bushels/Subarea:			**675**	**3,001**	**19,459**
		Total Bushels/Acre:			**4.04**	**17.97**	**116.6**

Other Species Noted: Spider Crab. Knobbed Whelk. Much Crepidula. Codium. Red Weed.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
8	33	2.35%	7.06%	22.35%	68.24%
	17	2.50%	8.60%	21.30%	67.50%
	19	7.90%	0.00%	10.50%	81.60%
	Avg. %:	**4.25**	**5.22**	**18.05**	**72.45**

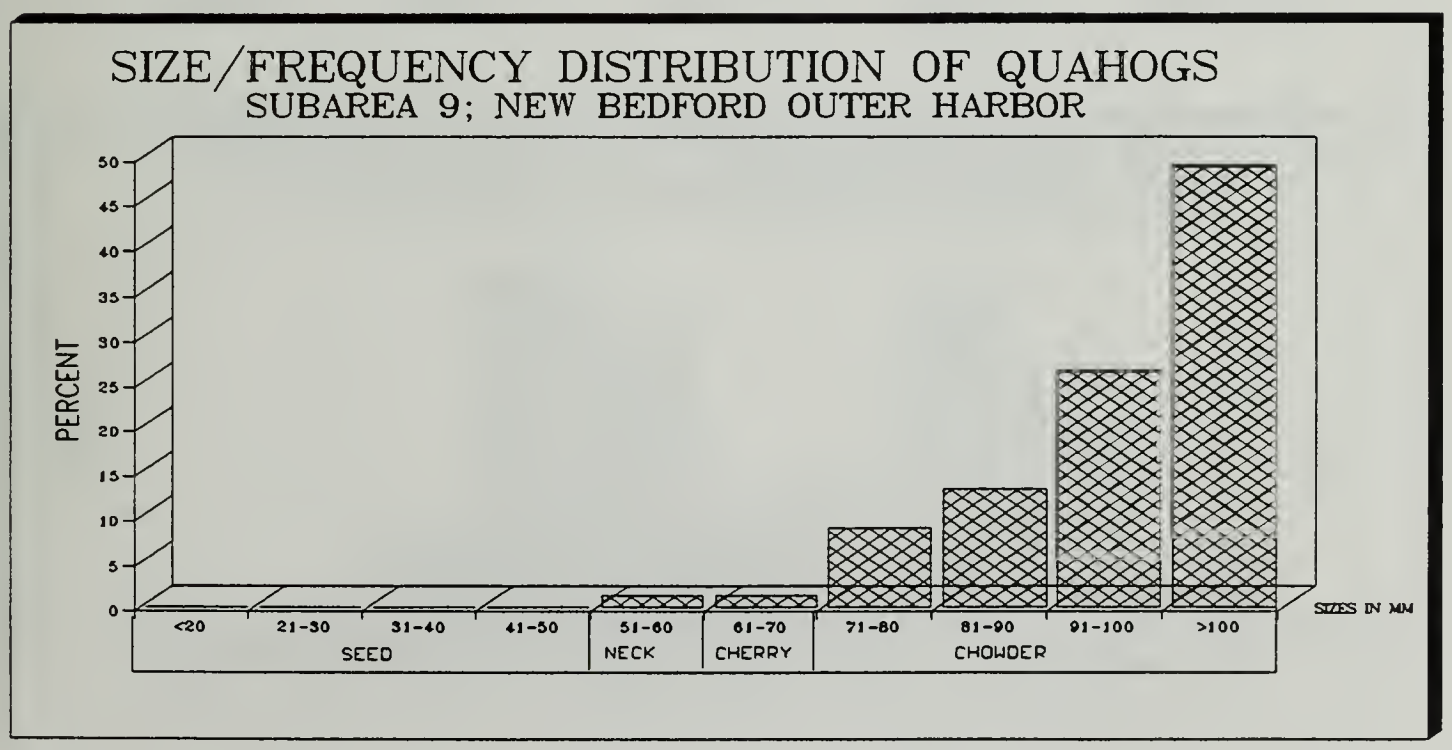


NEW BEDFORD OUTER HARBOR
Subarea 9

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
9	7,274,520	167	21	0.000	0.006	0.000	0.120
			35A	0.000	0.000	0.007	0.376
			35	0.000	0.000	0.000	0.061
		Avg./SqFt:		**0.000**	**0.002**	**0.0023**	**0.186**
		Total/Subarea:		**0.000**	**14,549**	**16,731**	**1,353,061**
		Total Bushels/Subarea:			**35**	**70**	**11,276**
		Total Bushels/Acre:			**.21**	**.42**	**67.52**

Other Species Noted: Channeled, Knobbed Whelk. Spider, Green Crab. Much Codium.
Bottom Type Noted: Gravelly sand with mud. Some quahog shack.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
9	21	0.00%	5.00%	0.00%	95.00%
	35A	0.00%	0.00%	1.92%	98.08%
	35	0.00%	0.00%	0.00%	100.00%
Avg. %:		**0.00**	**1.67**	**0.64**	**97.69**

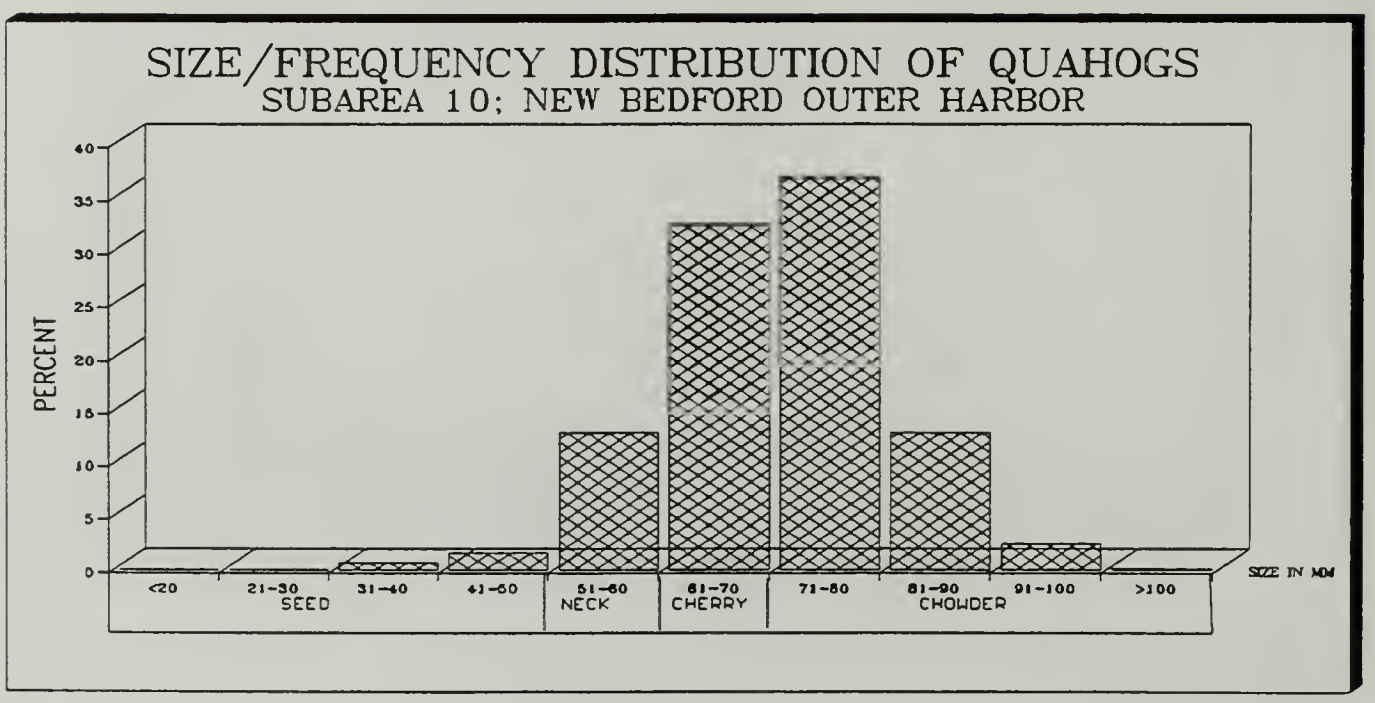


NEW BEDFORD OUTER HARBOR
Subarea 10

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
10	5,357,880	123	51A	0.012	0.083	0.193	0.221
			51	0.000	0.025	0.130	0.243
			38	0.021	0.077	0.107	0.369
			65	0.025	0.125	0.300	0.345
		Avg./SqFt		**0.015**	**0.078**	**0.183**	**0.294**
		Total/Subarea:		**80,368**	**417,915**	**980,492**	**1,575,217**
		Total Bushels/Subarea:			**995**	**4,085**	**13,127**
		Total Bushels/Acre:			**8.09**	**33.21**	**106.84**

Other Species Noted: Spider Crab. Crepidula. Many paired oyster shell. Lab sample.
Bottom Type Noted: Sandy mud with strong odor.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
10	51A	2.41%	16.27%	37.95%	43.37%
	51	0.00%	6.29%	32.70%	61.01%
	38	3.90%	13.60%	18.90%	63.60%
	65	3.14%	15.72%	37.74%	43.40%
Avg. %:		**2.36**	**12.97**	**31.82**	**52.84**



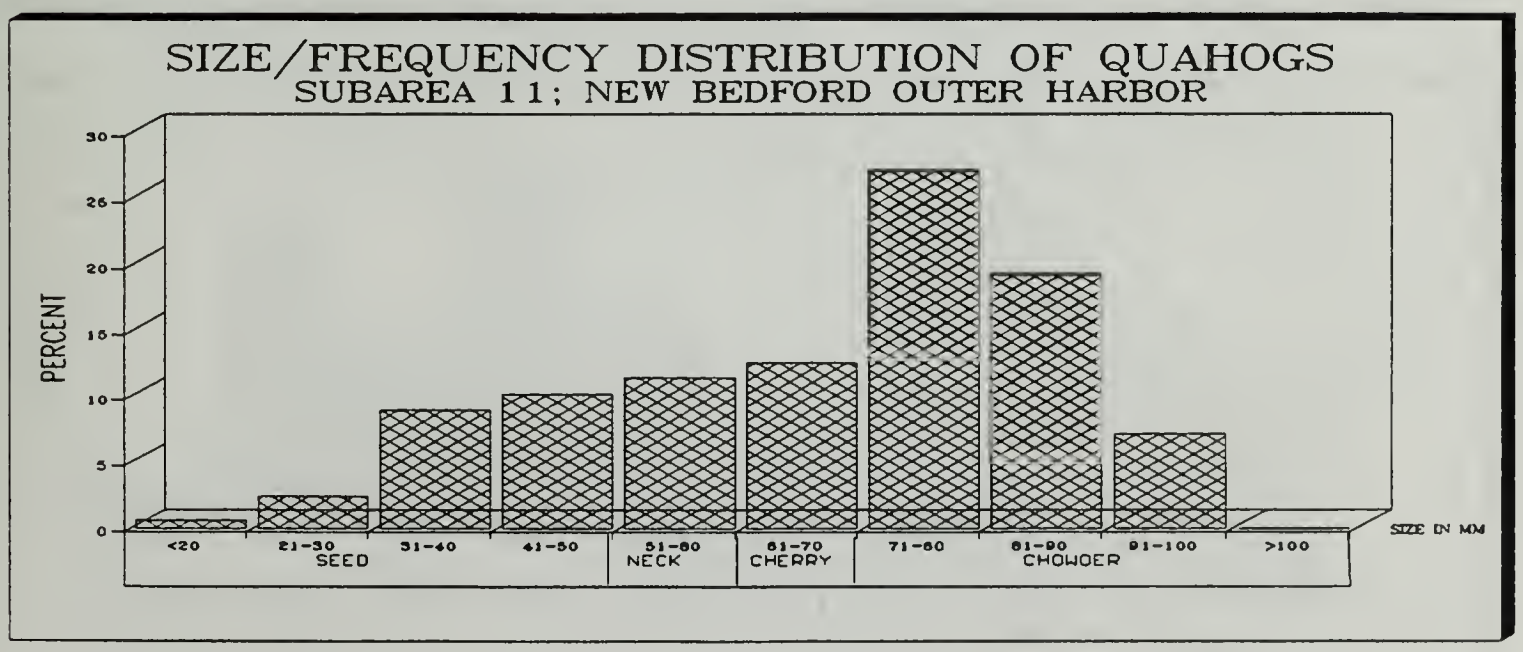
NEW BEDFORD OUTER HARBOR
Subarea 11

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
11	5,357,880	123	53	0.000	0.150	0.359	0.875
			55	0.082	0.038	0.088	0.554
			68	0.005	0.031	0.099	0.247
			40	0.118	0.097	0.233	0.287
			68A	0.002	0.002	0.016	0.228
			41	0.171	0.088	0.097	0.411
		Avg./SqFt		**0.063**	**0.068**	**0.148**	**0.434**
		Total/Subarea:		**337,935**	**364,336**	**792,966**	**2,325,320**
		Total Bushels/Subarea:			**867**	**3,304**	**19,378**
		Total Bushels/Acre:			**7.05**	**26.86**	**157.54**

Other Species Noted: Much Crepidula. Many oysters station 55. Many spider crabs. Much codium.

Bottom Type Noted: Firm sandy mud. Soft smelly mud at station 68.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
11	53	0.00%	10.85%	25.90%	63.20%
	55	10.87%	5.07%	11.59%	73.19%
	68	1.23%	8.02%	25.93%	64.81%
	40	16.10%	13.17%	31.71%	39.02%
	68A	0.90%	0.90%	6.31%	91.80%
	41	22.29%	11.45%	12.65%	53.50%
Avg. %:		**8.57**	**8.24**	**19.01**	**64.25**

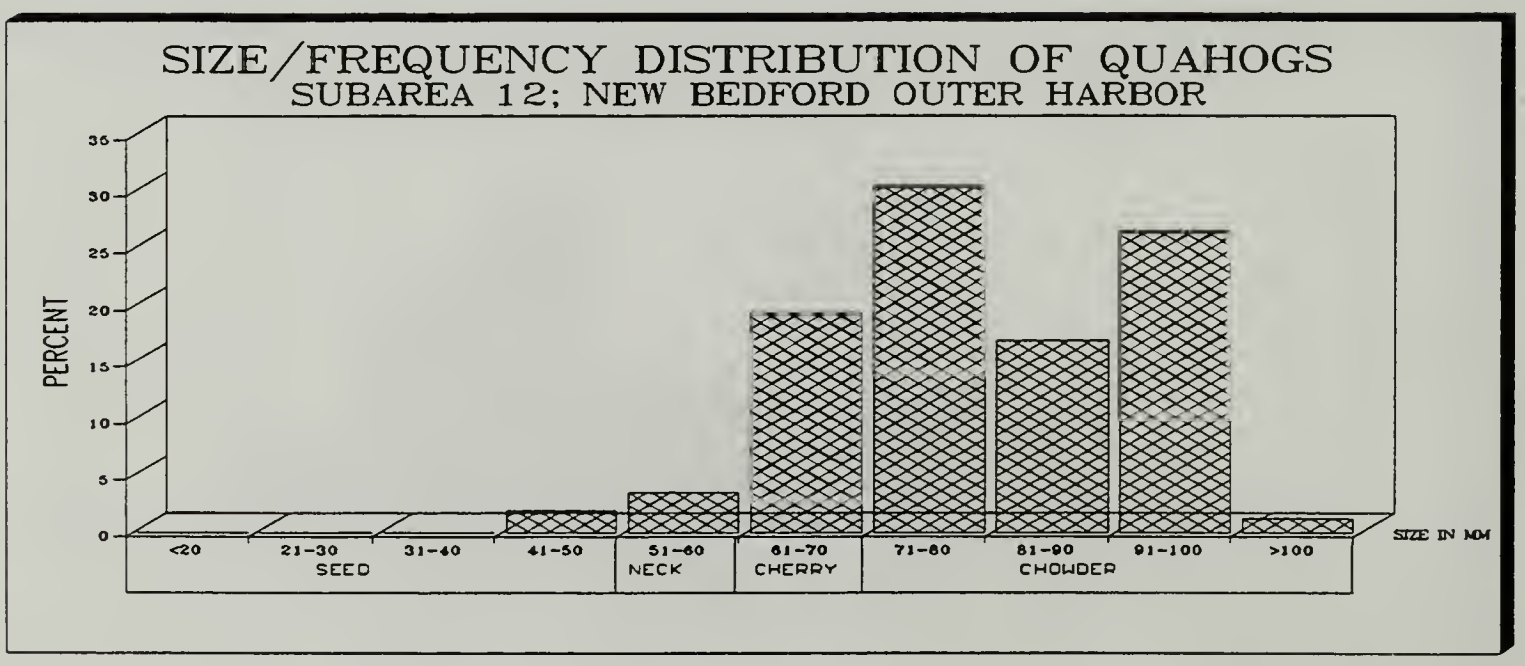


NEW BEDFORD OUTER HARBOR
Subarea 12

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
12	2,482,920	57	70	0.010	0.030	0.157	0.311
			44	0.002	0.000	0.002	0.112
		Avg./SqFt		**0.006**	**0.015**	**0.080**	**0.211**
		Total/Subarea:		**14,898**	**37,244**	**198,634**	**533,896**
		Total Bushels/Subarea:			**89**	**828**	**4,366**
		Total Bushels/Acre:			**1.56**	**14.52**	**76.6**

Other Species Noted: Much Crepidula. Few spider crabs. Much codium. Much quahog shack. Oily sheen on quahogs at station 70.
Bottom Type Noted: Sandy mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
12	70	1.97%	5.92%	30.92%	61.18%
	44	9.09%	0.00%	9.09%	81.82%
Avg. %:		**5.53**	**2.96**	**20.01**	**71.50**

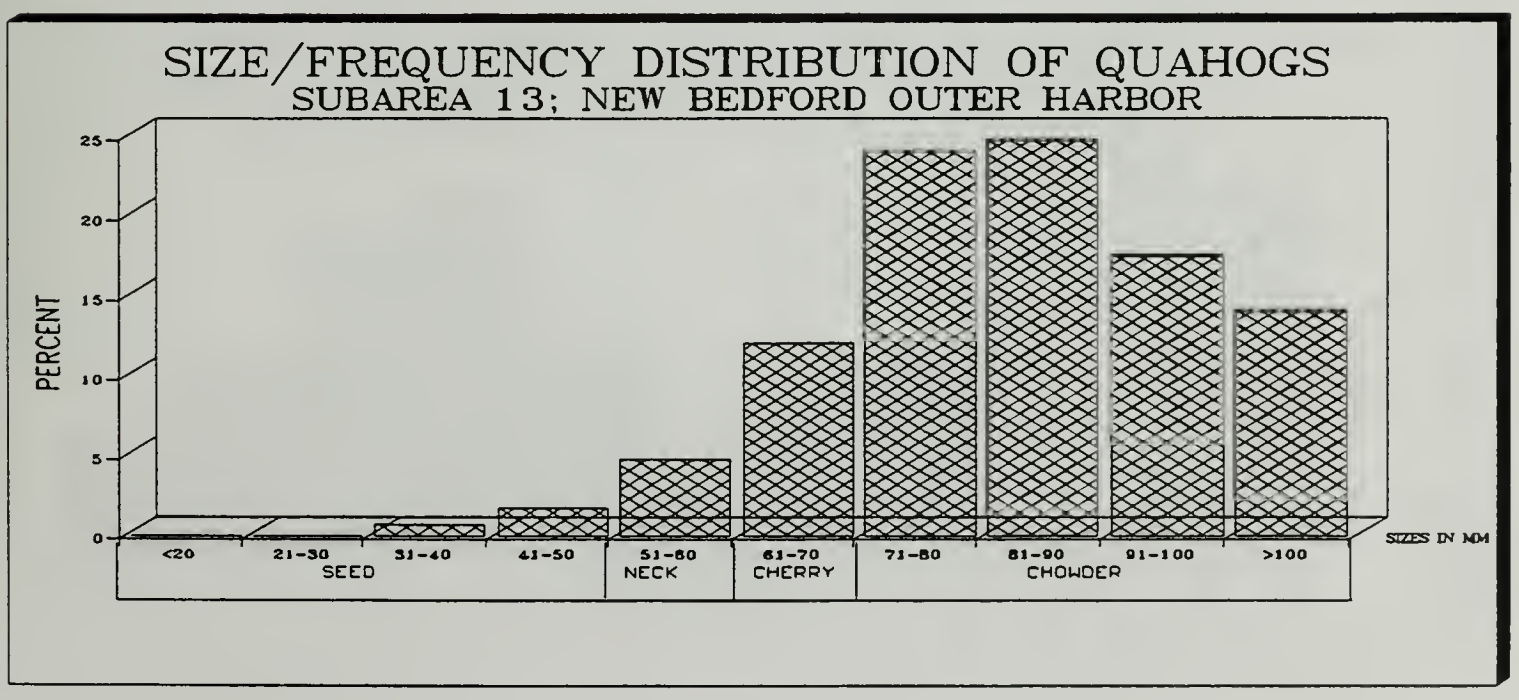


NEW BEDFORD OUTER HARBOR
Subarea 13

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
13	4,181,760	96	46	0.007	0.010	0.030	0.326
			60	0.001	0.004	0.001	0.053
			47	0.007	0.014	0.044	0.163
		Avg./SqFt:		**0.005**	**0.009**	**0.025**	**0.181**
		Total/Subarea:		**20,909**	**37,636**	**104,544**	**756,899**
		Total Bushels/Subarea:			**90**	**436**	**6,307**
		Total Bushels/Acre:			**0.93**	**4.54**	**65.74**

Other Species Noted: Much Crepidula. Lady crab. Few Spider crabs. Many starfish. Channeled whelk.
Bottom Type Noted: Sandy mud with small to medium cobble. Much shell shack and hash.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
13	46	1.79%	2.68%	8.04%	87.50%
	60	2.04%	6.12%	2.04%	89.80%
	47	3.10%	6.20%	19.38%	71.32%
Avg.	**%:**	**2.31**	**5.00**	**9.82**	**82.87**

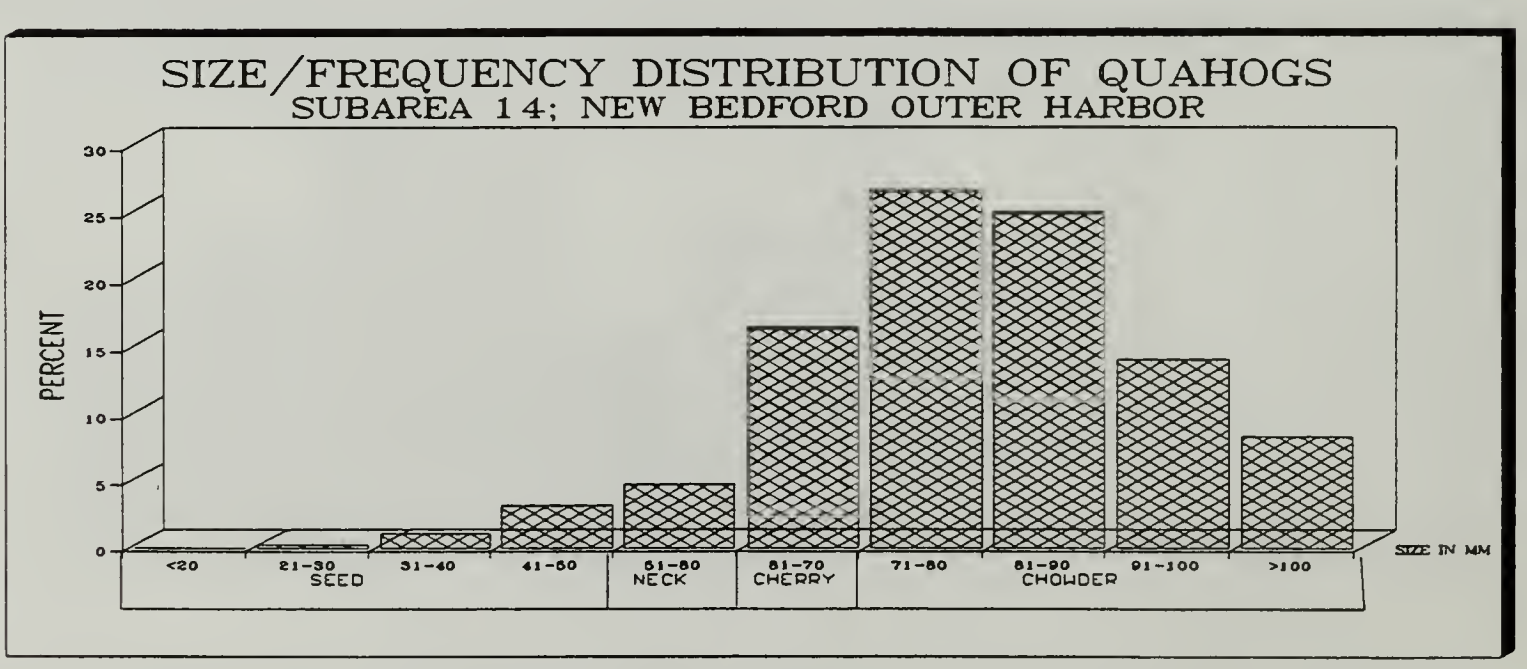


NEW BEDFORD OUTER HARBOR
Subarea 14

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
14	7,274,520	167	48	0.003	0.009	0.025	0.078
			74	0.013	0.010	0.008	0.077
			74B	0.031	0.012	0.050	0.392
			50	0.000	0.005	0.018	0.094
			62	0.002	0.003	0.043	0.130
		Avg./SqFt:		**0.010**	**0.008**	**0.029**	**0.154**
		Total/Subarea:		**72745**	**58,196**	**210,961**	**1,120,276**
		Total Bushels/Subarea:			**139**	**879**	**9,336**
		Total Bushels/Acre:			**0.83**	**5.27**	**55.95**

Other Species Noted: Much Crepidula. Many small sand crabs. Few knobbed whelk, spider crabs, starfish. Some codium.
Bottom Type Noted: Relatively firm sand with small to medium cobble.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
14	48	3.06%	8.16%	22.45%	68.37%
	74	12.31%	9.23%	7.69%	70.77%
	74B	6.35%	2.38%	10.32%	80.95%
	50	0.00%	4.44%	15.56%	80.00%
	62	0.97%	1.94%	24.27%	72.82%
Avg. %:		**4.54**	**5.23**	**16.06**	**74.58**

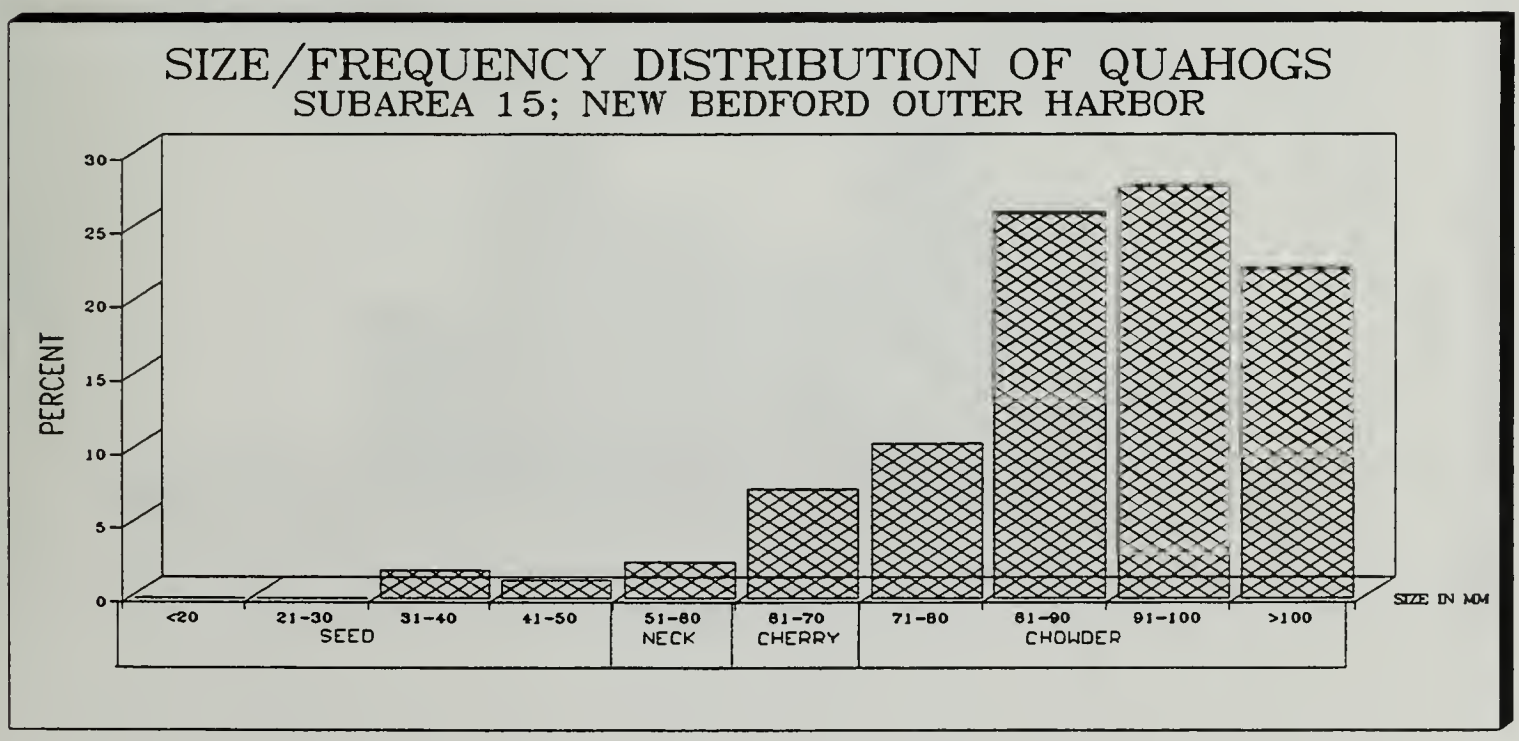


NEW BEDFORD OUTER HARBOR
Subarea 15

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
15	1,698,840	39	76A	0.010	0.000	0.010	0.297
			76	0.006	0.008	0.019	0.153
		Avg./SqFt:		**0.008**	**0.004**	**0.014**	**0.225**
		Total/Subarea:		**13,591**	**6,795**	**23,784**	**382,239**
		Total Bushels/Subarea:			**16**	**99**	**3,185**
		Total Bushels/Acre:			**0.41**	**2.64**	**81.67**

Other Species Noted: Much Crepidula. Channeled whelk. Knobbed whelk. Few spider crabs. Some codium.
Bottom Type Noted: Sandy mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
15	76A	3.17%	0.00%	3.17%	93.65%
	76	3.06%	4.08%	10.20%	82.65%
	Avg. %:	**3.12**	**2.04**	**6.69**	**88.15**

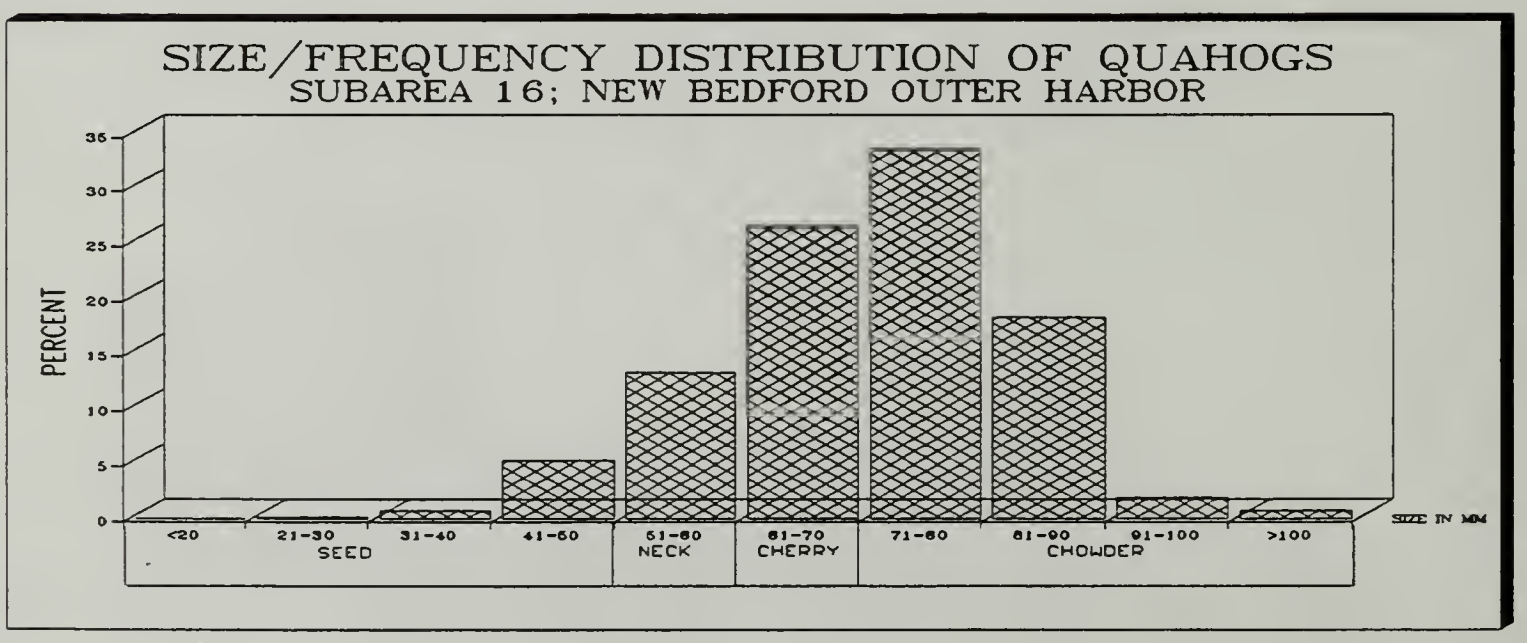


NEW BEDFORD OUTER HARBOR
Subarea 16

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
16	4,660,920	107	80	0.065	0.079	0.097	0.267
			78	0.010	0.024	0.063	0.242
			93	0.011	0.028	0.087	0.089
			79	0.005	0.023	0.047	0.130
			91A	0.008	0.031	0.107	0.230
			91	0.013	0.036	0.057	0.067
		Avg./AqFt:		**0.019**	**0.037**	**0.076**	**0.171**
		Total/Subarea:		**88,557**	**172,454**	**354,230**	**797,017**
		Total Bushels/Subarea:			**411**	**1,476**	**6,642**
		Total Bushels/Acre:			**3.84**	**13.79**	**62.07**

Other Species Noted: Much Crepidula. Few spider crabs and channeled whelk. Bay scallop. Oily sheen on quahogs at station 78.
Bottom Type Noted: Firm sandy mud with medium cobble (sta. 91). Much shell hash.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
16	80	12.89%	15.46%	19.07%	52.58%
	78	2.92%	7.02%	18.71%	71.35%
	93	4.90%	13.22%	40.50%	42.15%
	79	2.63%	11.18%	23.03%	63.16%
	91A	2.24%	8.21%	28.36%	61.19%
	91	7.55%	20.75%	33.02%	39.15%
Avg. %:		**5.52**	**12.64**	**27.11**	**54.93**

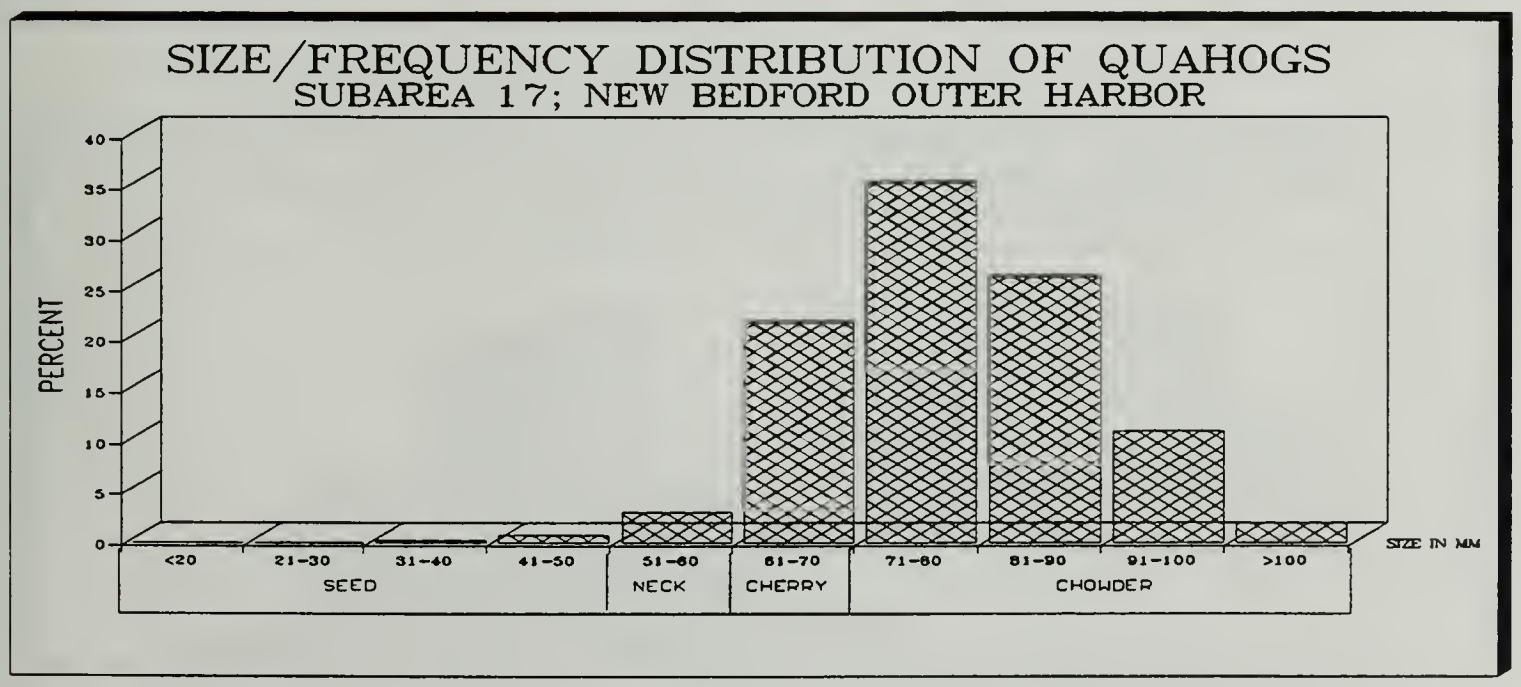


NEW BEDFORD OUTER HARBOR
Subarea 17

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
17	6,316,200	145	81	0.000	0.000	0.090	0.417
			83	0.023	0.029	0.070	0.680
			94	0.000	0.011	0.079	0.139
		Avg./SqFt:		**0.008**	**0.014**	**0.080**	**0.412**
		Total/Subarea:		**50,530**	**88,427**	**505,296**	**2,602,274**
		Total Bushels/Subarea:			**210**	**2,105**	**21,686**
		Total Bushels/Acre:			**1.45**	**14.52**	**149.6**

Other Species Noted: Much Crepidula. Starfish. Oily sheen on quahogs at station 94.
Bottom Type Noted: Sandy mud with small cobble. Muddy smelly sand at station 94.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
17	81	0.00%	0.00%	17.81%	82.19%
	83	2.92%	3.65%	8.76%	84.67%
	94	0.00%	4.92%	34.43%	60.66%
Avg. %:		**0.97**	**2.86**	**20.33**	**75.84**

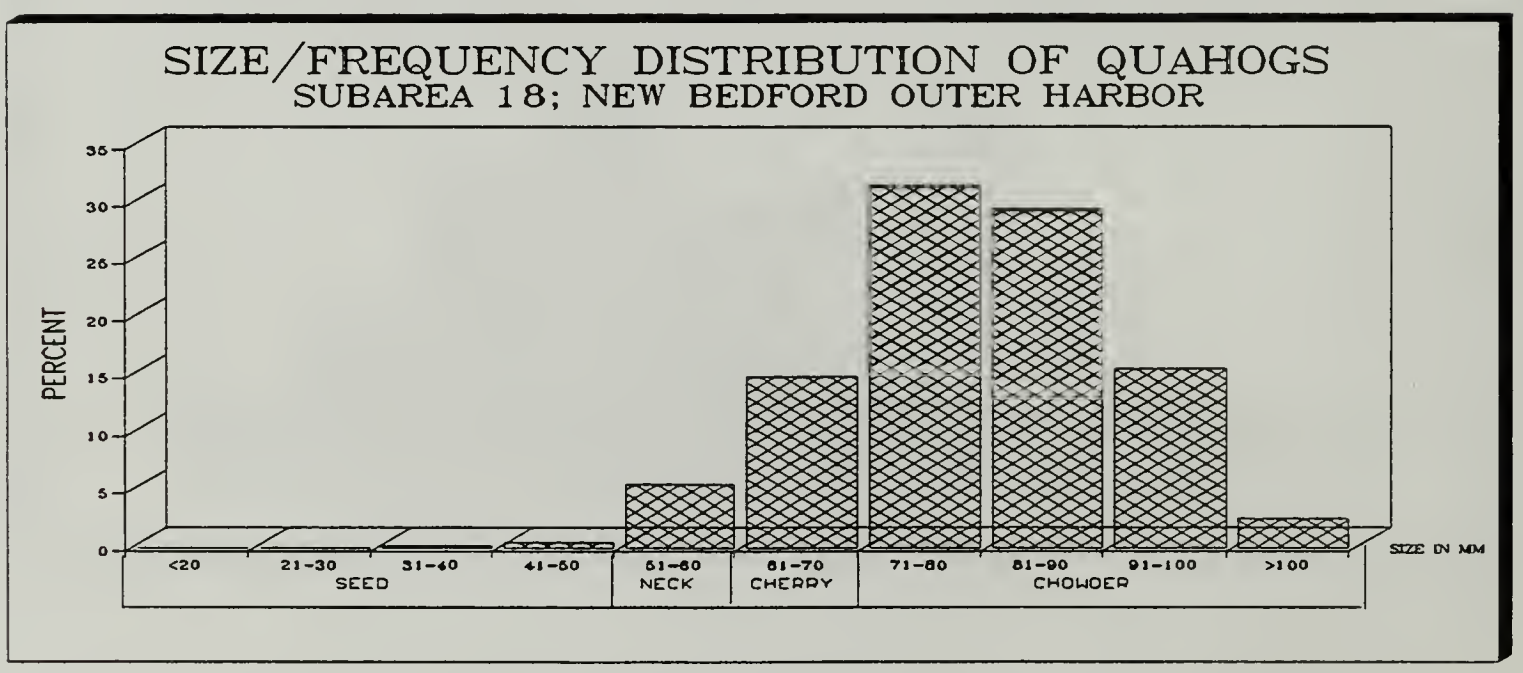


NEW BEDFORD OUTER HARBOR
Subarea 18

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
18	7,274,520	167	85	0.001	0.003	0.015	0.141
			84	0.000	0.013	0.079	0.617
			96	0.000	0.026	0.046	0.272
			98	0.005	0.026	0.062	0.174
		Avg./SqFt:		**0.002**	**0.017**	**0.050**	**0.301**
		Total/Subarea:		**14,549**	**123,667**	**363,726**	**2,189,631**
		Total Bushels/Subarea:			**294**	**1,516**	**18,246**
		Total Bushels/Acre:			**1.76**	**9.1**	**109.26**

Other Species Noted: Toadfish. Many starfish. Few knobbed and channeled whelk. Few spider crab. Moon snail.
Bottom Type Noted: Sand with medium to large cobble; large boulders (sta. 84) . Station 96 small cobble in firm sand with mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
18	85	0.87%	1.74%	9.57%	87.83%
	84	0.00%	1.86%	11.18%	86.96%
	96	0.00%	7.69%	13.29%	79.02%
	98	1.73%	9.83%	23.12%	65.32%
	Avg. %:	**0.65**	**5.28**	**14.29**	**79.78**

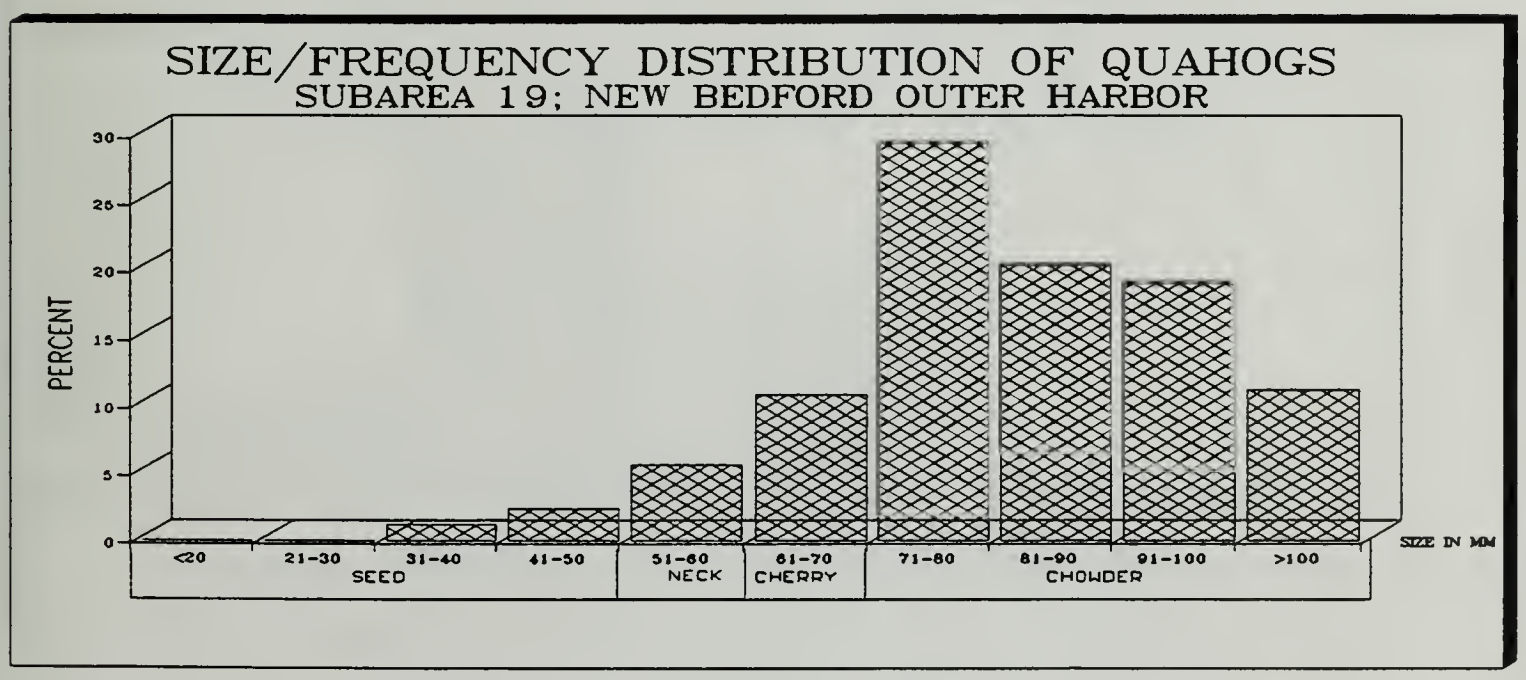


NEW BEDFORD OUTER HARBOR
Subarea 19

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
19	7,274,520	167	100	0.005	0.006	0.006	0.084
			87	0.001	0.004	0.013	0.037
			86	0.002	0.002	0.003	0.073
		Avg./SqFt:		**0.003**	**0.004**	**0.007**	**0.065**
		Total/Subarea:		**21,824**	**29,098**	**50,922**	**472,844**
		Total Bushels/Subarea:			**69**	**212**	**3,940**
		Total Bushels/Acre:			**0.41**	**1.27**	**23.6**

Other Species Noted: Few knobbed whelk, spider crabs, green crabs. Many starfish. Much codium.
Bottom Type Noted: Sandy gravel with medium cobble.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
19	100	4.76%	5.56%	6.35%	83.33%
	87	2.67%	8.00%	22.67%	66.67%
	86	2.00%	2.00%	4.00%	92.00%
	Avg. %:	**3.14**	**5.19**	**11.01**	**80.67**



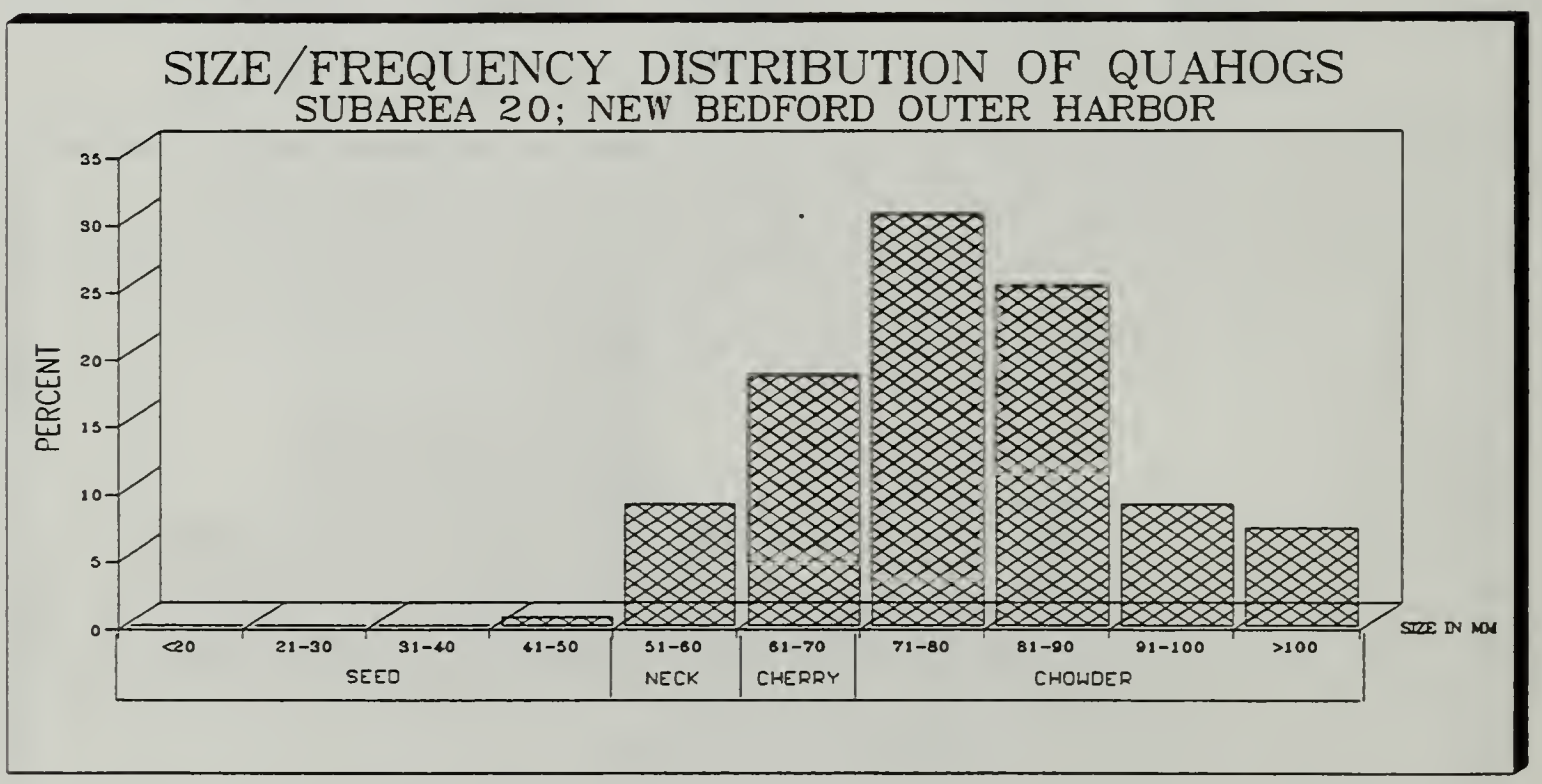
NEW BEDFORD OUTER HARBOR
Subarea 20

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
20	5,357,880	123	89	0.002	0.022	0.049	0.179
			102	0.000	0.002	0.002	0.012
		Avg./SqFt:		**0.001**	**0.012**	**0.026**	**0.096**
		Total/Subarea:		**5,358**	**64,295**	**139,305**	**514,356**
		Total Bushels/Subarea:			**153**	**580**	**4,286**
		Total Bushels/Acre:			**1.24**	**4.72**	**34.84**

Other Species Noted: Much Crepidula. Knobbed whelk. Some codium.

Bottom Type Noted: Firm sand with much shell hash.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
20	89	0.72%	9.35%	20.86%	69.06%
	102	0.00%	10.53%	10.53%	78.95%
	Avg. %:	**0.36**	**9.94**	**15.69**	**74.00**

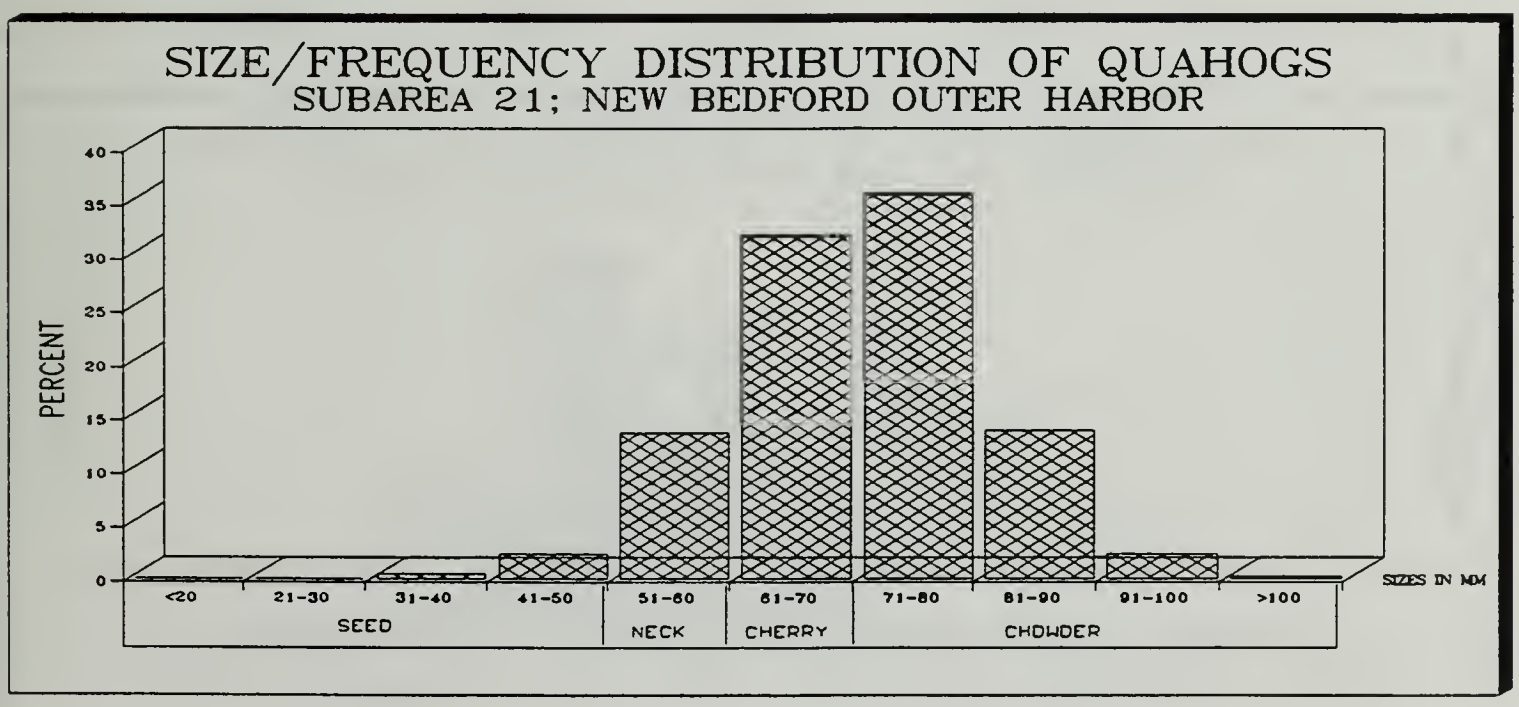


NEW BEDFORD OUTER HARBOR
Subarea 21

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
21	5,445,000	125	116A	0.009	0.030	0.067	0.134
			104	0.002	0.019	0.039	0.092
			116	0.010	0.060	0.154	0.172
		Avg./SqFt:		**0.007**	**0.036**	**0.087**	**0.133**
		Total/Subarea:		**38,115**	**196,020**	**473,715**	**724,185**
		Total Bushels/Subarea:			**467**	**1,974**	**6,035**
		Total Bushels/Acre:			**3.73**	**15.79**	**48.3**

Other Species Noted: Few spider crabs and knobbed whelk. Oily sheen on quahogs at station 116. Mantis shrimp.
Bottom Type Noted: Soft mud with sand. Strong odor. Much quahog shack and hash.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
21	116A	3.73%	12.42%	27.95%	55.90%
	104	1.56%	12.50%	25.78%	60.16%
	116	2.53%	15.15%	38.89%	43.43%
Avg. %:		**2.60**	**13.36**	**30.87**	**53.16**



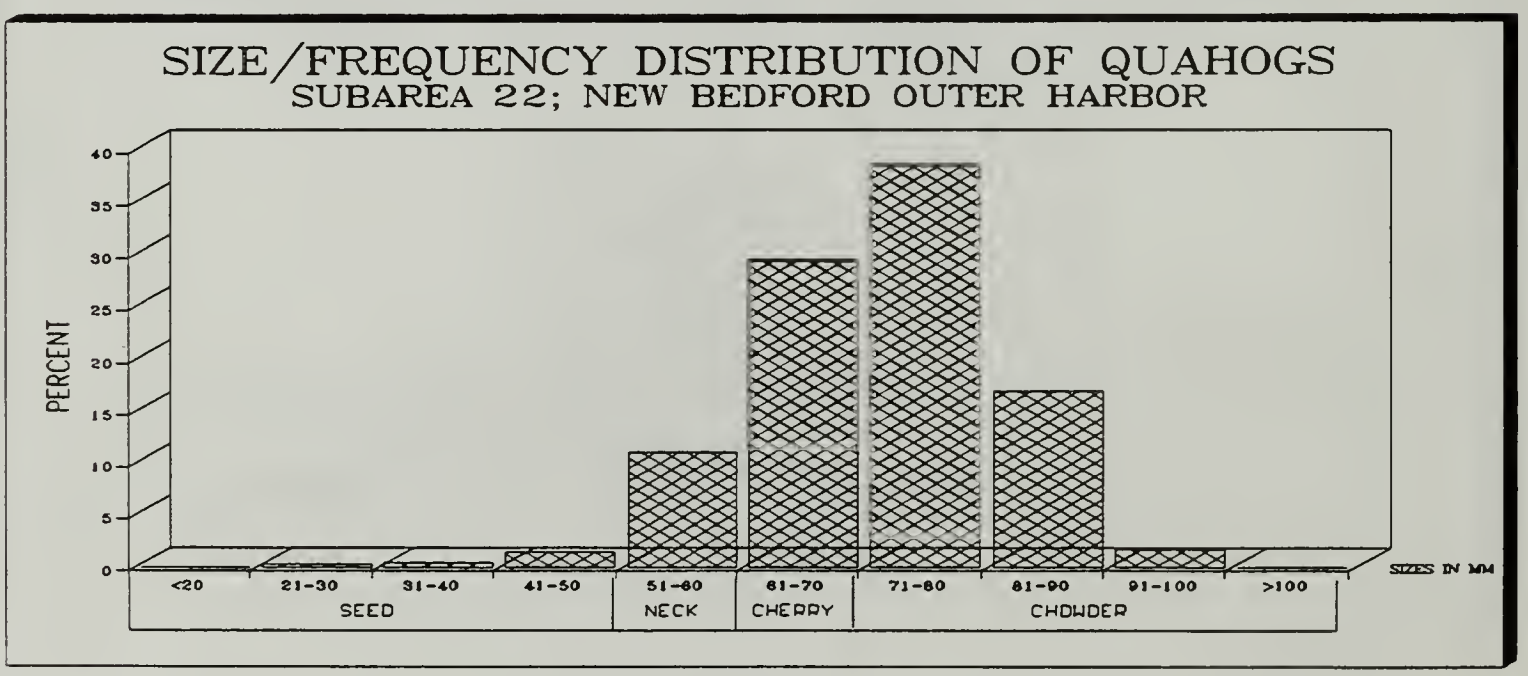
NEW BEDFORD OUTER HARBOR
Subarea 22

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
22	5,357,880	123	118A	0.001	0.015	0.045	0.110
			107	0.042	0.149	0.334	0.560
			118	0.007	0.033	0.060	0.090
			105	0.000	0.009	0.080	0.175
		Avg./SqFt:		**0.012**	**0.052**	**0.130**	**0.234**
		Total/Subarea:		**64,295**	**278,610**	**696,524**	**1,253,744**
		Total Bushels/Subarea:			**663**	**2,902**	**10,448**
		Total Bushels/Acre:			**5.39**	**23.59**	**84.9**

Other Species Noted: Much Crepidula. Few spider crabs and knobbed whelks. Oily sheen on quahogs at station 118. Quahog sample for lab.

Bottom Type Noted: Very soft smelly black mud station 118. Substrate west of channel in this subarea appears to almost all mud. Substrate east is firmer gravelly sand.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
22	118A	0.53%	9.00%	26.50%	64.02%
	107	3.85%	13.74%	30.77%	51.65%
	118	3.85%	17.69%	31.54%	47.69%
	105	0.00%	3.33%	30.00%	65.83%
Avg. %:		**2.06**	**10.94**	**29.70**	**57.30**



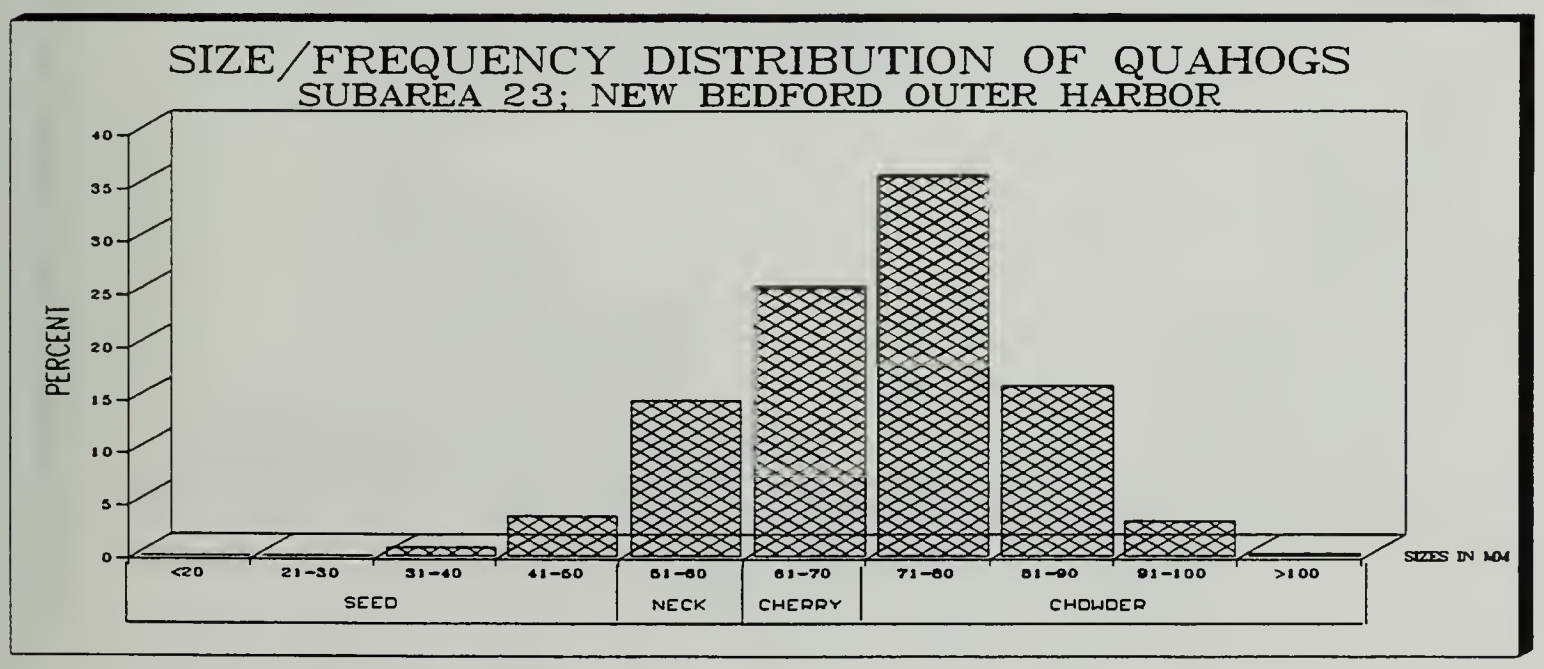
NEW BEDFORD OUTER HARBOR
Subarea 23

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
23	5,837,040	134	109	0.020	0.095	0.170	0.529
			120	0.073	0.209	0.326	0.477
			120A	0.000	0.007	0.056	0.236
		Avg./SqFt:		**0.031**	**0.104**	**0.184**	**0.414**
		TotalSubarea:		**180,948**	**607,052**	**1,074,015**	**2416,535**
		Total Bushels/Subarea:			**1,445**	**4,475**	**20,138**
		Total Bushels/Acre:			**10.78**	**33.39**	**150.28**

Other Species Noted: Much Crepidula.

Bottom Type Noted: Relatively soft sandy mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
23	109	2.45%	11.66%	20.86%	65.03%
	120	6.73%	19.28%	30.04%	43.95%
	120A	0.00%	2.33%	18.60%	79.07%
Avg. %:		**3.06**	**11.09**	**23.17**	**62.68**

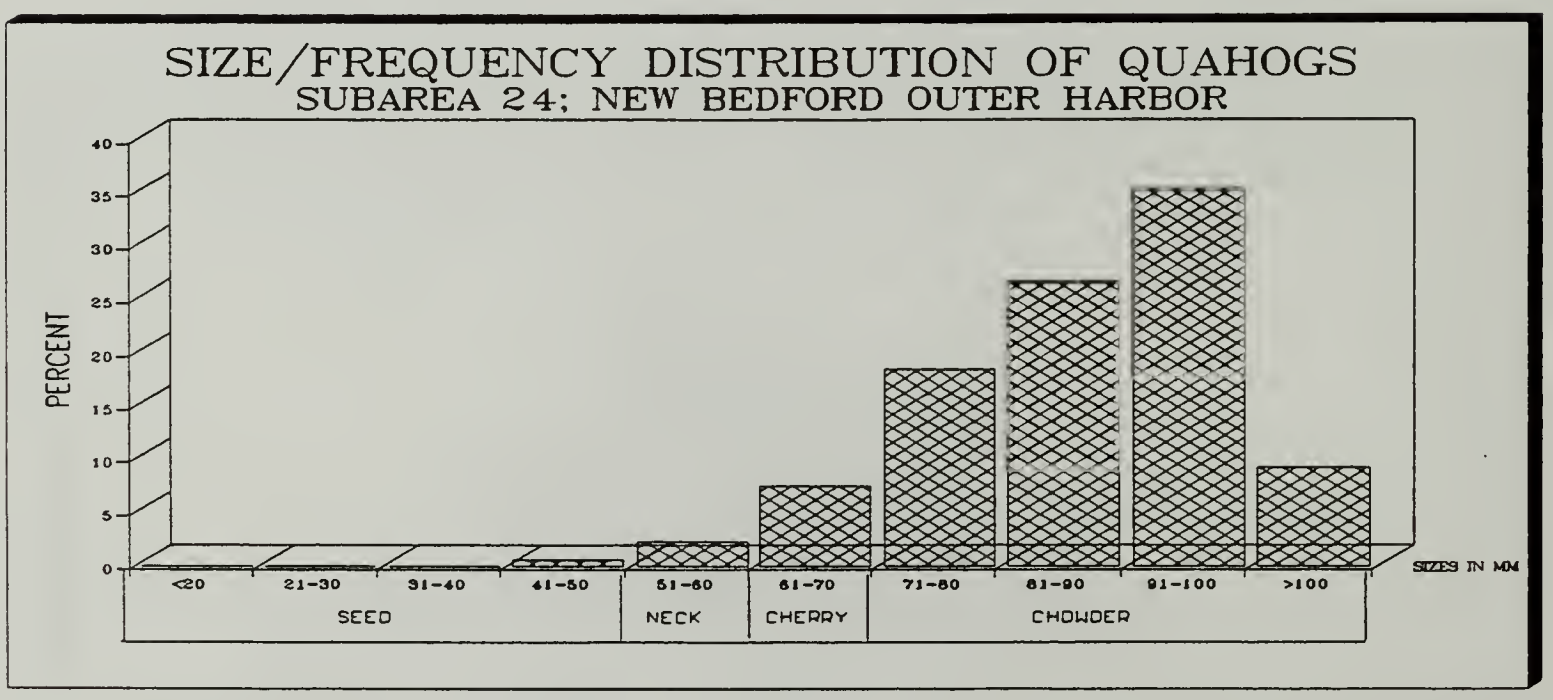


NEW BEDFORD OUTER HARBOR
Subarea 24

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
24	7,274,520	167	122	0.002	0.006	0.020	0.074
			113	0.000	0.000	0.014	0.432
			111	0.000	0.002	0.004	0.175
		Avg./SqFt:		**0.001**	**0.003**	**0.013**	**0.227**
		Total/Subarea:		**7,275**	**21,824**	**94,569**	**1,651,316**
		Total Bushels/Subarea:			**52**	**394**	**13,761**
		Total Bushels/Acre:			**0.31**	**2.36**	**82.4**

Other Species Noted: Few spider crabs, channeled and knobbed whelk. Much Crepidula. Some codium.
Bottom Type Noted: Relatively firm gravelly sand with medium cobble.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
24	122	1.96%	5.88%	19.61%	72.55%
	113	0.00%	0.00%	3.03%	96.97%
	111	0.00%	1.12%	2.25%	96.63%
	Avg. %:	**0.65**	**2.34**	**8.30**	**88.72**



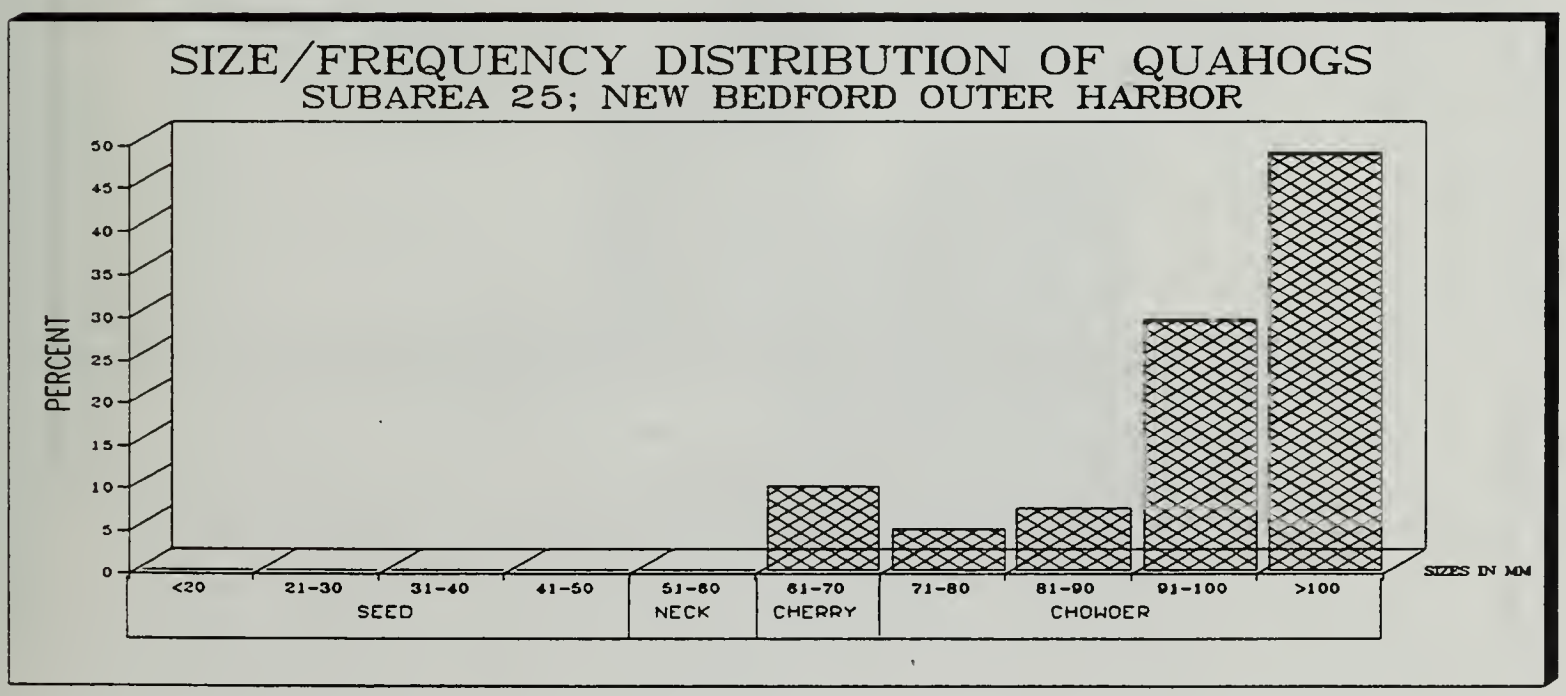
NEW BEDFORD OUTER HARBOR
Subarea 25

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
25	6,316,200	145	124	0.000	0.000	0.018	0.067
			126	0.000	0.000	0.000	0.010
			126A	0.000	0.000	0.000	0.014
		Avg./SqFt:		**0.000**	**0.000**	**0.006**	**0.030**
		Total/Subarea:		**0.000**	**0.000**	**37,897**	**189,486**
		Total Bushels/Subarea:			**0.000**	**158**	**1,579**
		Total Bushels/Acre:			**0.000**	**1.09**	**10.9**

Other Species Noted: Much Crepidula. Many small sand crabs. Few spider crabs and knobbed whelk. Pitar. Much codium.

Bottom Type Noted: Relatively soft sand with medium cobble.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
25	124	0.00%	0.00%	21.05%	78.95%
	126	0.00%	0.00%	0.00%	100.00%
	126A	0.00%	0.00%	0.00%	100.00%
Avg. %:		**0.00**	**0.00**	**7.02**	**92.98**



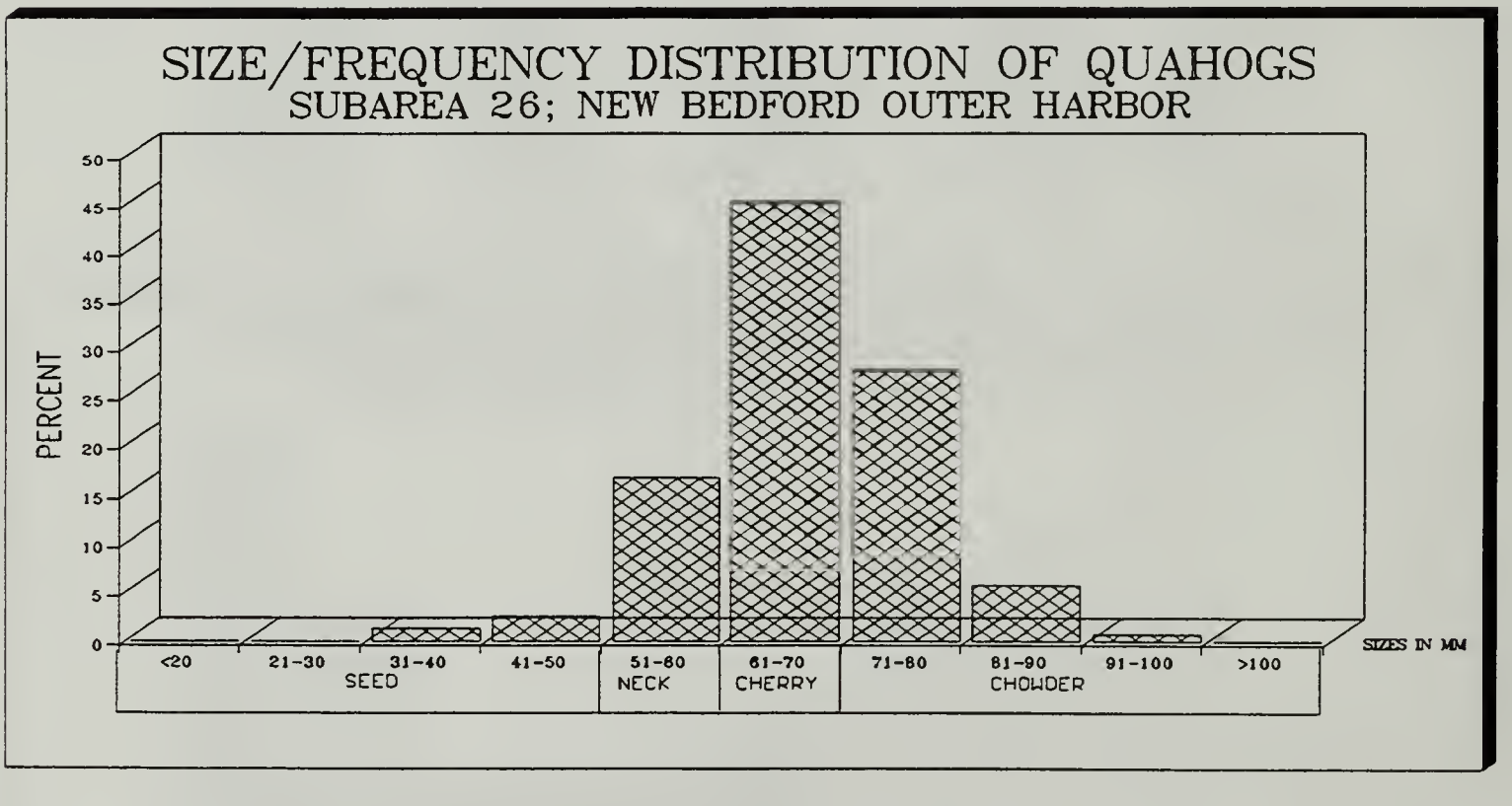
NEW BEDFORD OUTER HARBOR
Subarea 26

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
26	1,481,040	34	127	0.008	0.035	0.095	0.072
		Total/Subarea:		**118,483**	**51,836**	**140,699**	**106,635**
		Total Bushels/Subarea:			**123**	**586**	**889**
		Total Bushels/Acre:			**3.63**	**17.24**	**26.13**

Other Species Noted: Much Crepidula. Oily sheen on quahogs at station 127.

Bottom Type Noted: Soft smelly mud.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
26	127	3.87%	16.77%	45.16%	34.19%
	Avg. %:	**3.87**	**16.77**	**45.16**	**34.19**

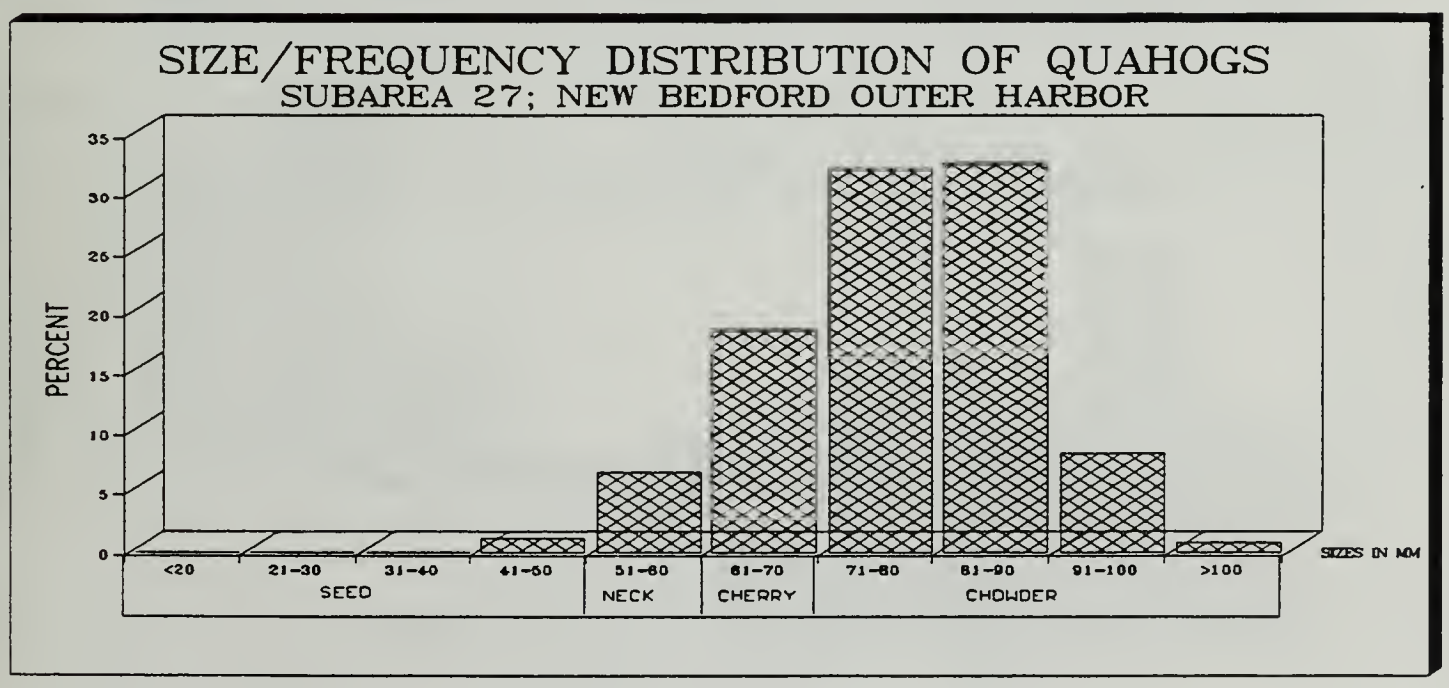


NEW BEDFORD OUTER HARBOR
Subarea 27

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
27	2,787,840	64	133A	0.000	0.004	0.038	0.304
			131	0.013	0.074	0.161	0.611
			133	0.004	0.023	0.064	0.193
		Avg./SqFt:		**0.006**	**0.034**	**0.088**	**0.369**
		Total/Subarea:		**16,727**	**94,787**	**245,330**	**1,028,713**
		Total Bushels/Subarea:			**226**	**1,022**	**8,573**
		Total Bushels/Acre:			**3.5**	**15.97**	**134.9**

Other Species Noted: Some Crepidula and codium. Oily sheen on quahogs station 131. Much dead quahog seed noted station 133. Much quahog shack.
Bottom Type Noted: Muddy sand.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
27	133A	0.00%	1.11%	11.11%	87.78%
	131	1.56%	8.59%	18.75%	71.09%
	133	1.26%	8.18%	22.64%	67.92%
	Avg. %:	**0.94**	**5.96**	**17.50**	**75.60**

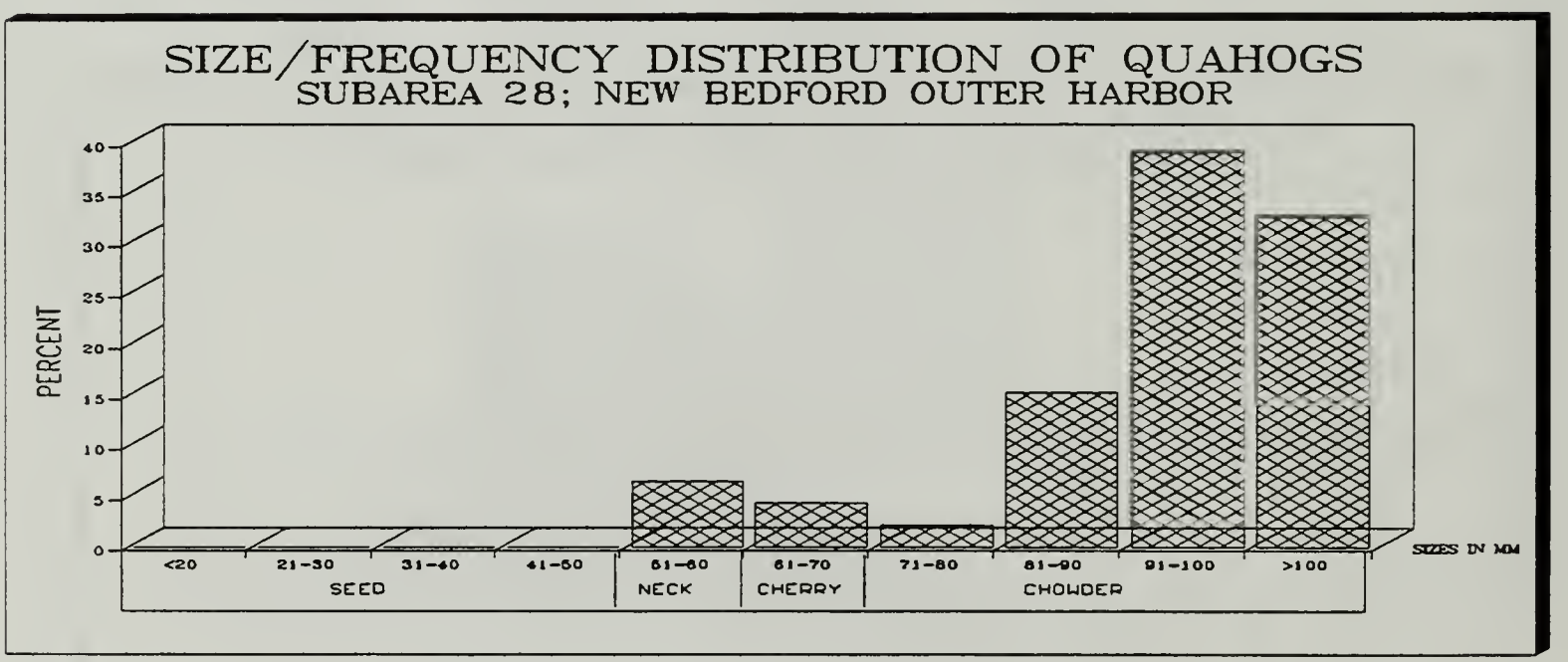


NEW BEDFORD OUTER HARBOR
Subarea 28

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
28	3,528,360	81	135A	0.000	0.000	0.000	0.200
			135	0.000	0.020	0.013	0.093
		Avg./SqFt:		**0.000**	**0.010**	**0.007**	**0.147**
		Total/Subarea:		**0.000**	**35,284**	**24,699**	**518,669**
		Total Bushels/Subarea:			**84**	**103**	**4,322**
		Total Bushels/Acre:			**1.03**	**1.27**	**53.4**

Other Species Noted: Much general seaweed and codium. Some blue mussel, Crepidula, spider crab, green crab, knobbed whelk.
Bottom Type Noted: Muddy sand with some gravel.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
28	135A	0.00%	0.00%	0.00%	100.00%
	135	0.00%	15.79%	10.53%	73.68%
	Avg. %:	**0.00**	**7.89**	**5.26**	**86.84**



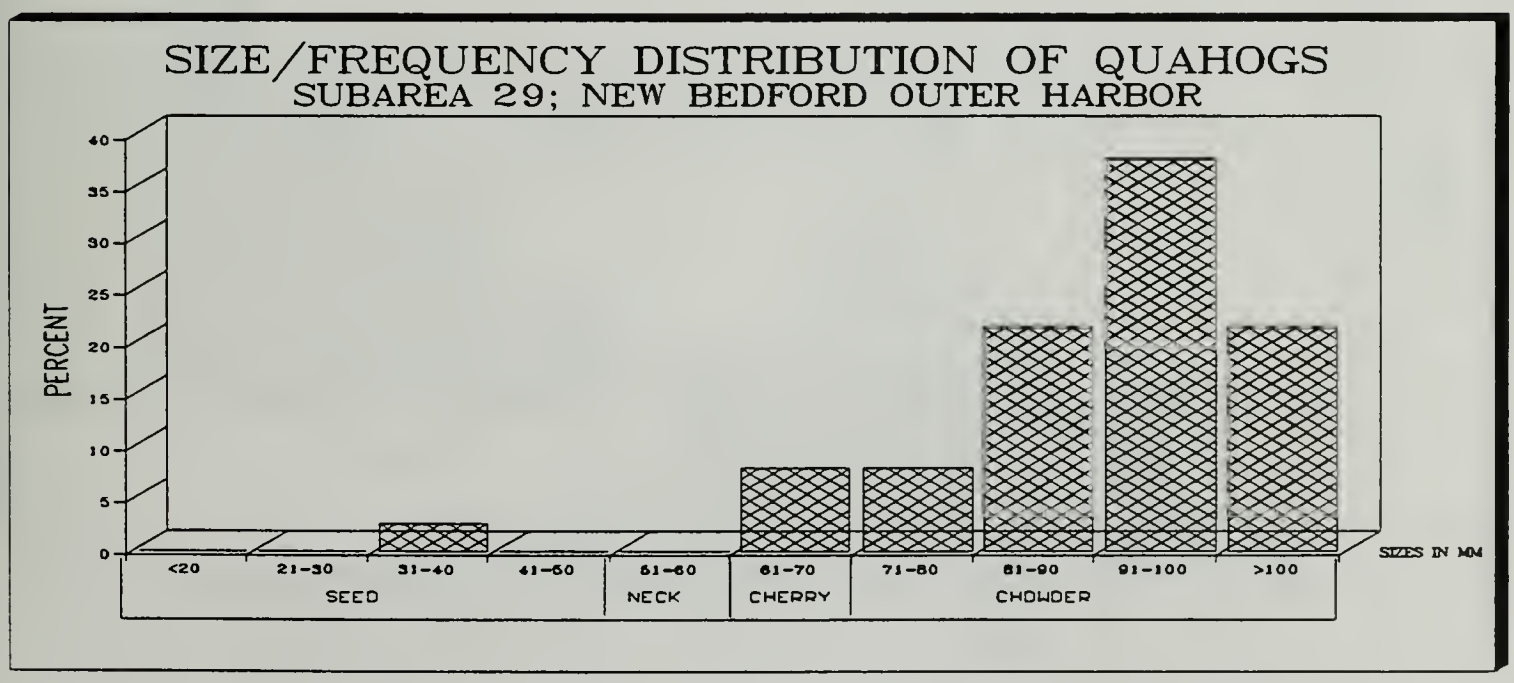
NEW BEDFORD OUTER HARBOR
Subarea 29

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
29	5,837,040	134	141	0.000	0.000	0.000	0.052
			136	0.011	0.000	0.033	0.276
		Avg./SqFt:		**0.006**	**0.000**	**0.017**	**0.164**
		Total/Subarea:		**35022**	**0.000**	**99,230**	**957,275**
		Total Bushels/Subarea:			**0.000**	**413**	**7,977**
		Total Bushels/Acre:			**0.000**	**3.01**	**59.55**

Other Species Noted: Few knobbed whelk, channeled whelk, spider crab. Starfish. Heavy codium.

Bottom Type Noted: Very firm sand with some gravel and small cobble.

SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
29	1	41	0.00%	0.00%	0.00%	100.00%
	136	3.45%	0.00%	10.34%	86.21%
Avg. %:		**1.72**	**0.00**	**5.17**	**93.10**

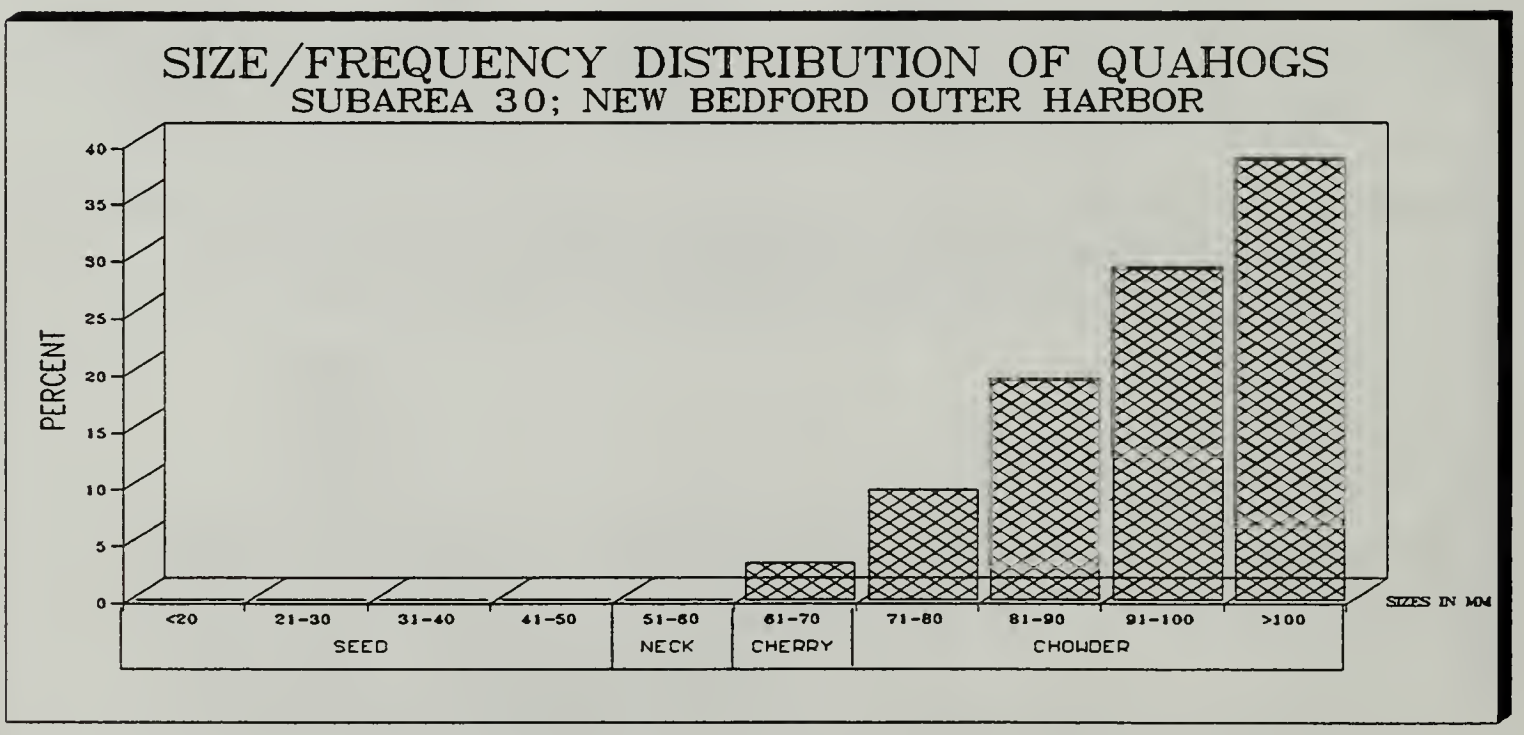


NEW BEDFORD OUTER HARBOR
Subarea 30

Sub-Area	SqFt/ Subarea	Acres/ Subarea	Sta. #	Seed/ SqFt	Neck/ SqFt	Cherry/ SqFt	Chowder/ SqFt
30	5,357,880	123	139	0.000	0.000	0.001	0.019
			143	0.000	0.000	0.000	0.462
		Avg./SqFt:		**0.000**	**0.000**	**0.001**	**0.241**
		Total/Subarea:		**0.000**	**0.000**	**5,358**	**1,291,249**
		Total Bushels/Subarea:			**0.000**	**22**	**10,760**
		Total Bushels/Acre:			**0.000**	**.18**	**87.5**

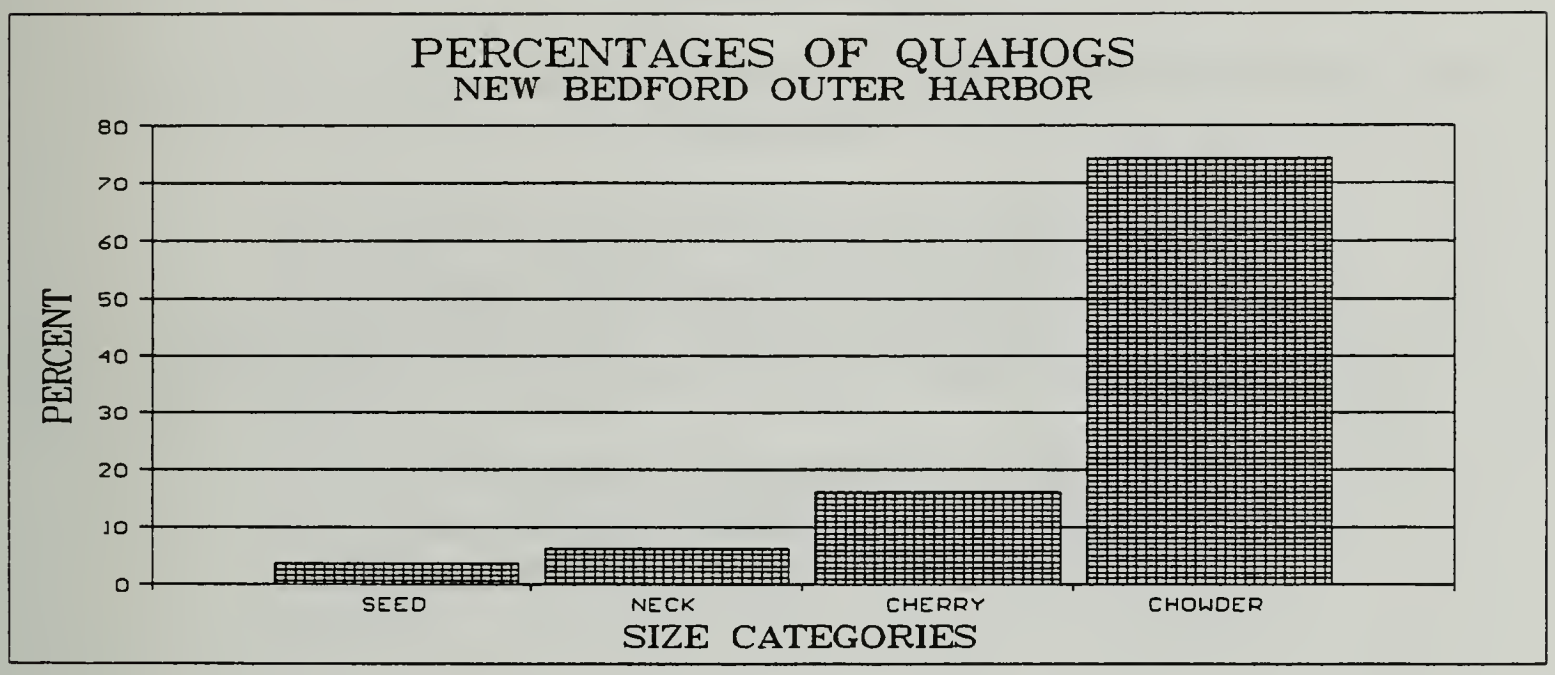
Other Species Noted: Some Crepidula. Few Channeled and knobbed whelk. Few spider crabs and starfish. Much codium.
Bottom Type Noted: Sand with some mud and small cobble.

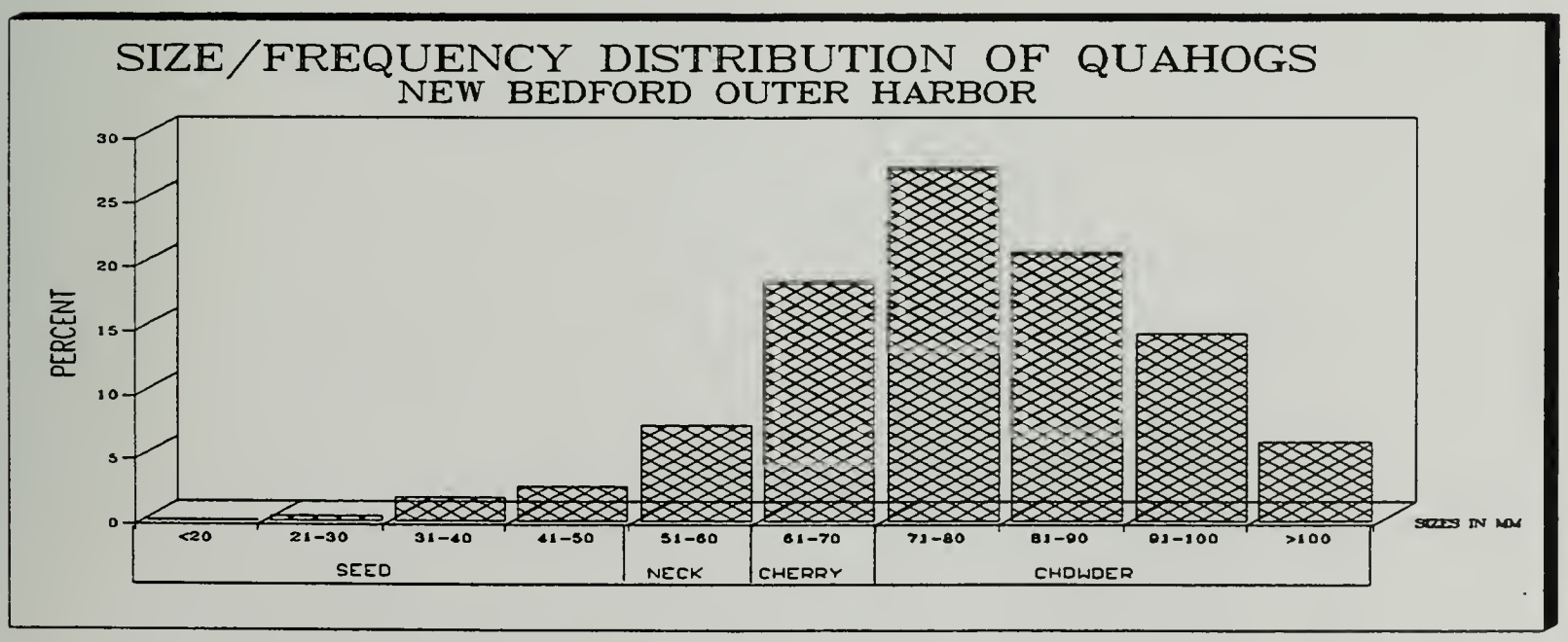
SUBAREA	STATION	SEED	NECK	CHERRY	CHOWDER
30	139	0.00%	0.00%	6.67%	93.33%
	143	0.00%	0.00%	0.00%	100.00%
	Avg. %:	**0.00**	**0.00**	**3.33**	**96.67**



QUAHOG STANDING CROP ASSESSMENT
NEW BEDFORD OUTER HARBOR

Area Square Feet	Area Acres		Seed	Littleneck	Cherrystone	Chowder
137,170,440	3149					
		Total Quahogs:	**1,565,474**	**3,416,146**	**8,332,105**	**33,534,227**
		Total Bushels:		**8,133.68**	**34,717.10**	**279,452**
		Avg. Bushels/Acre:		**2.58**	**11.03**	**88.74**



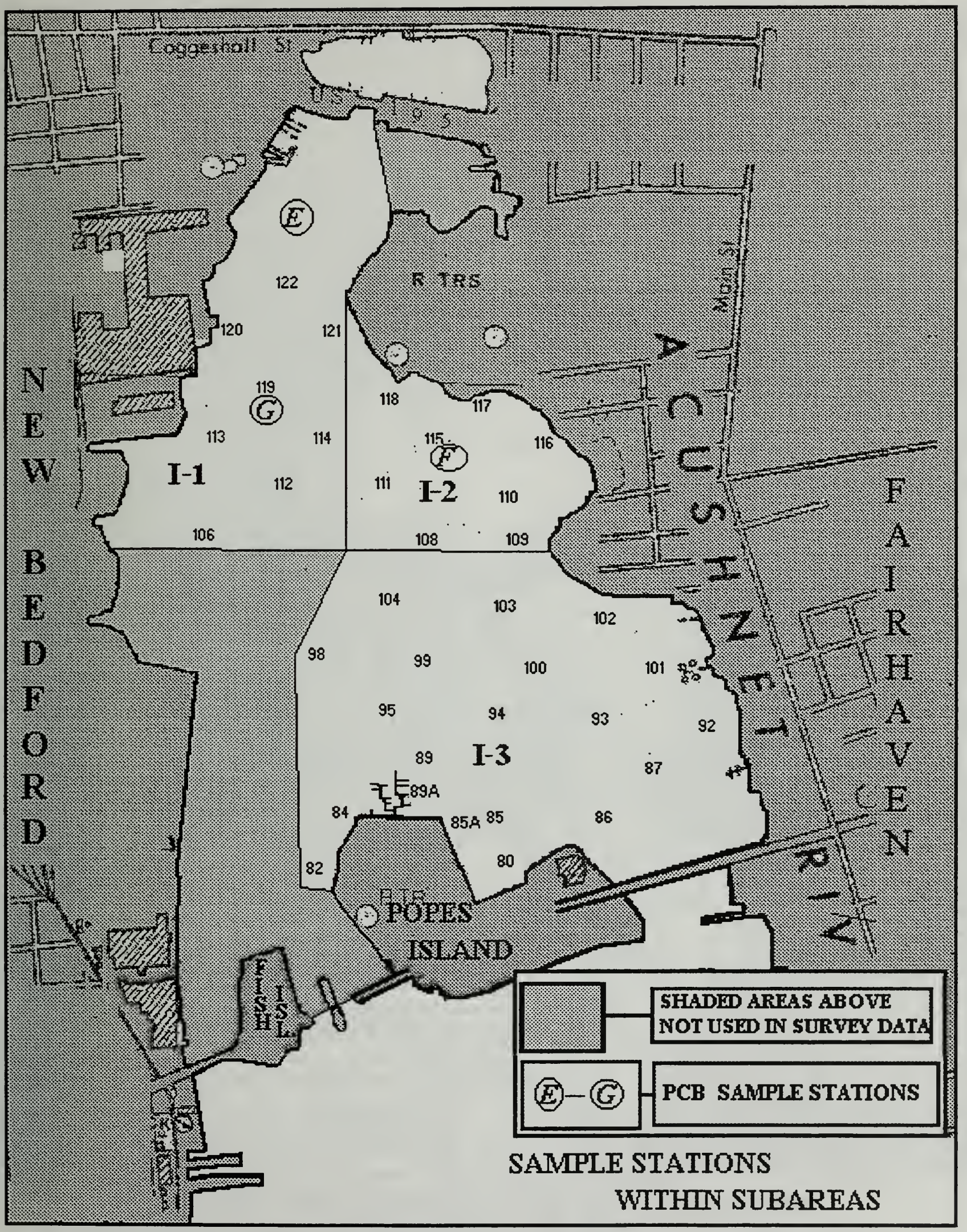


APPENDIX D

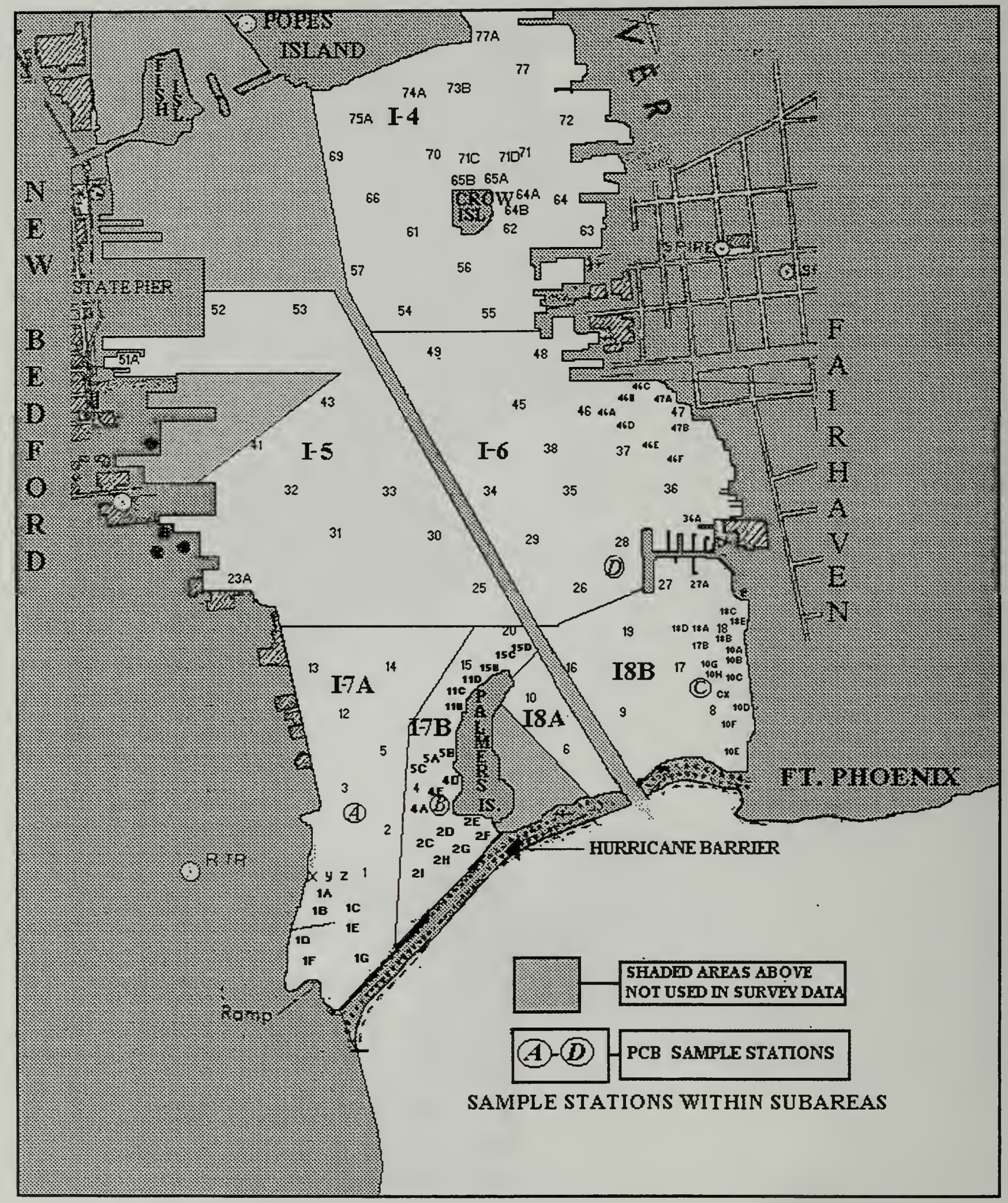
Maps of New Bedford Inner and Outer Harbor Quahog Standing Crop Assessment

Inner Harbor (upper portion); Sample Station Locations
Inner Harbor (lower portion); Sample Station Locations
Inner Harbor; Standing Crop per Subarea (Total Bushels/Subarea)
Inner Harbor; Standing Crop per Subarea (Total Bushels/Acre/Subarea)

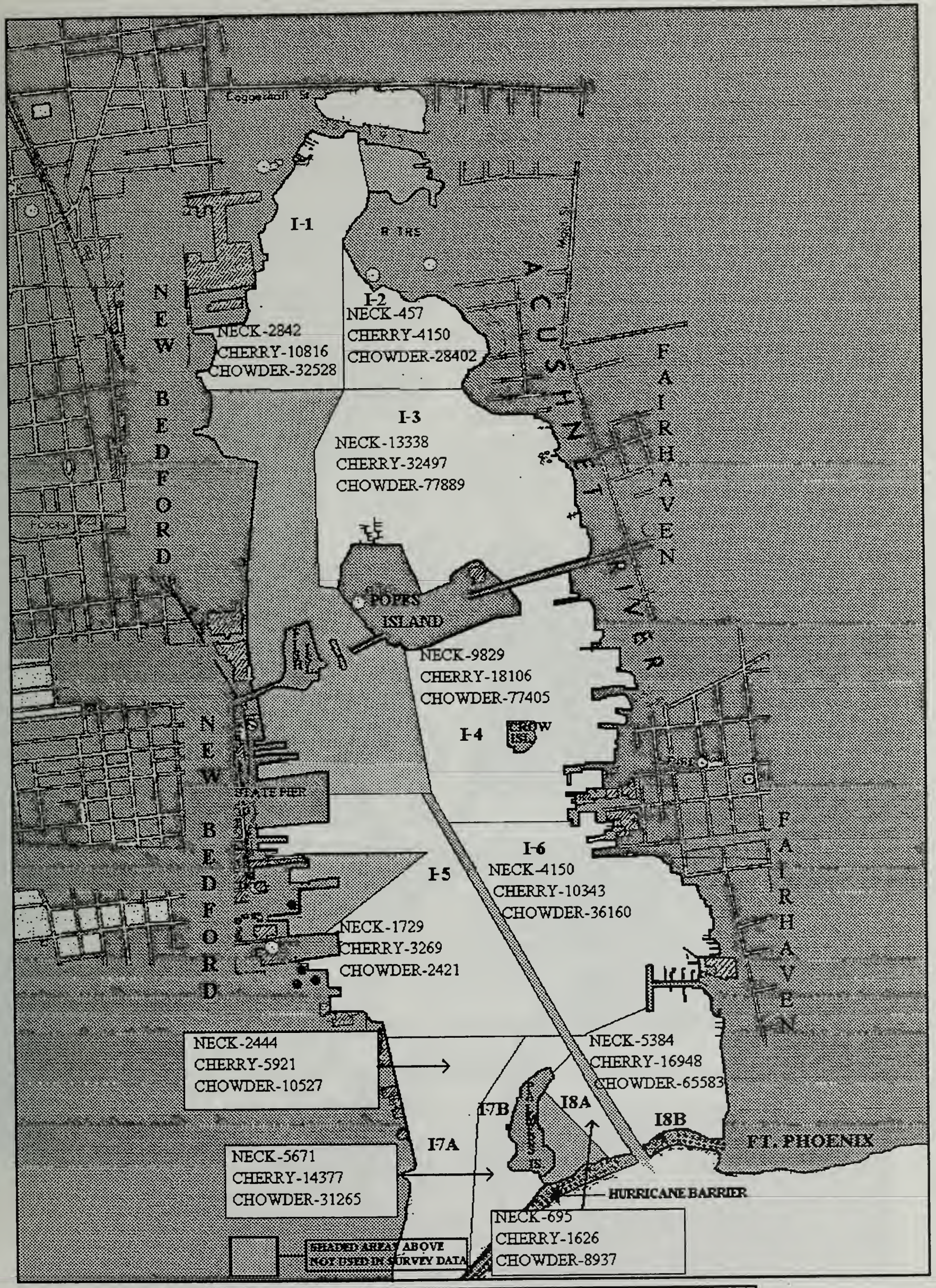
Outer Harbor; Sample Station Locations
Outer Harbor; Standing Crop per Subarea
Outer Harbor; Distribution of Quahog Crop



NEW BEDFORD INNER HARBOR STANDING CROP SURVEY
(UPPER PORTION)

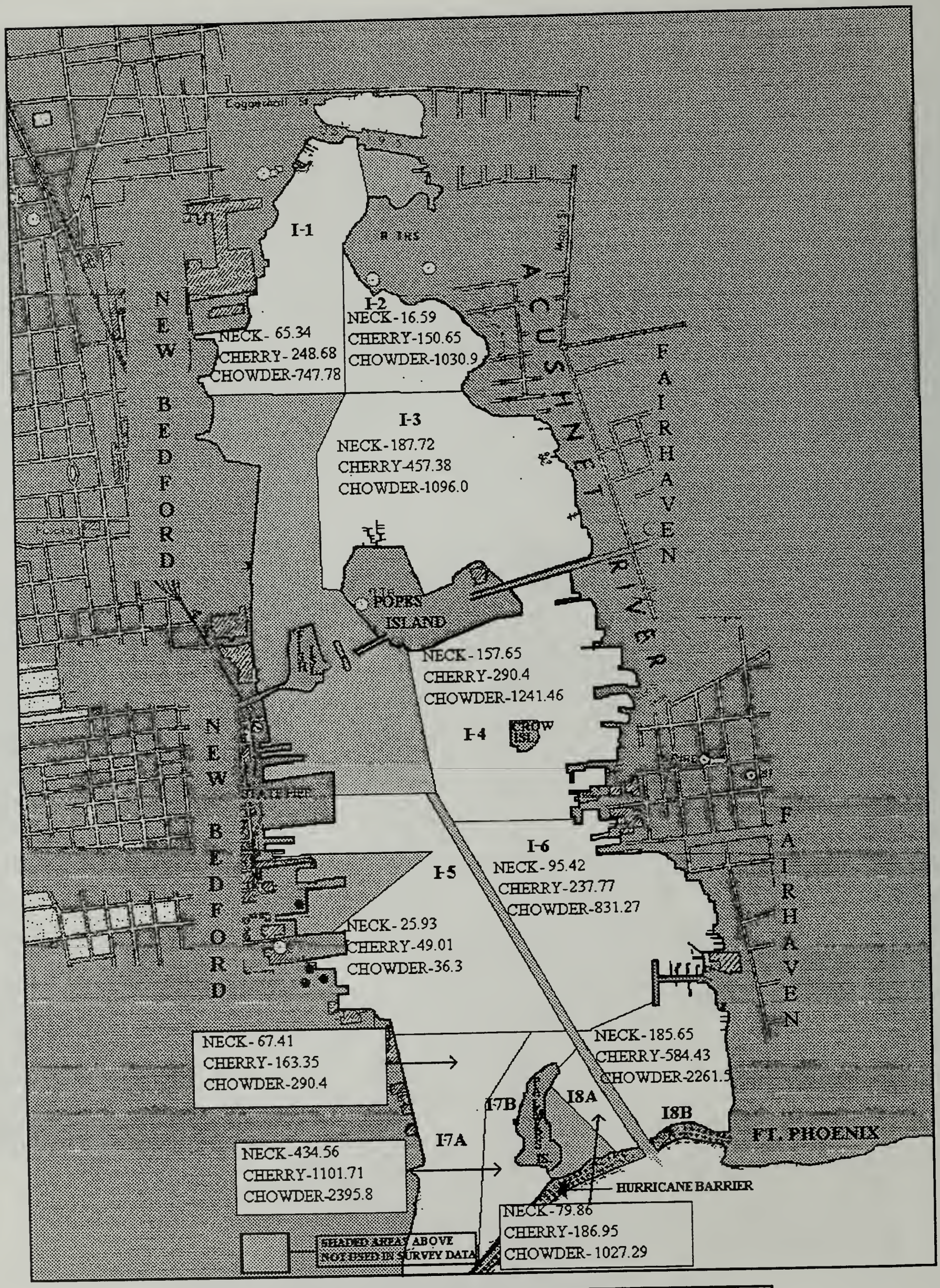


NEW BEDFORD INNER HARBOR STANDING CROP SURVEY
(LOWER PORTION)



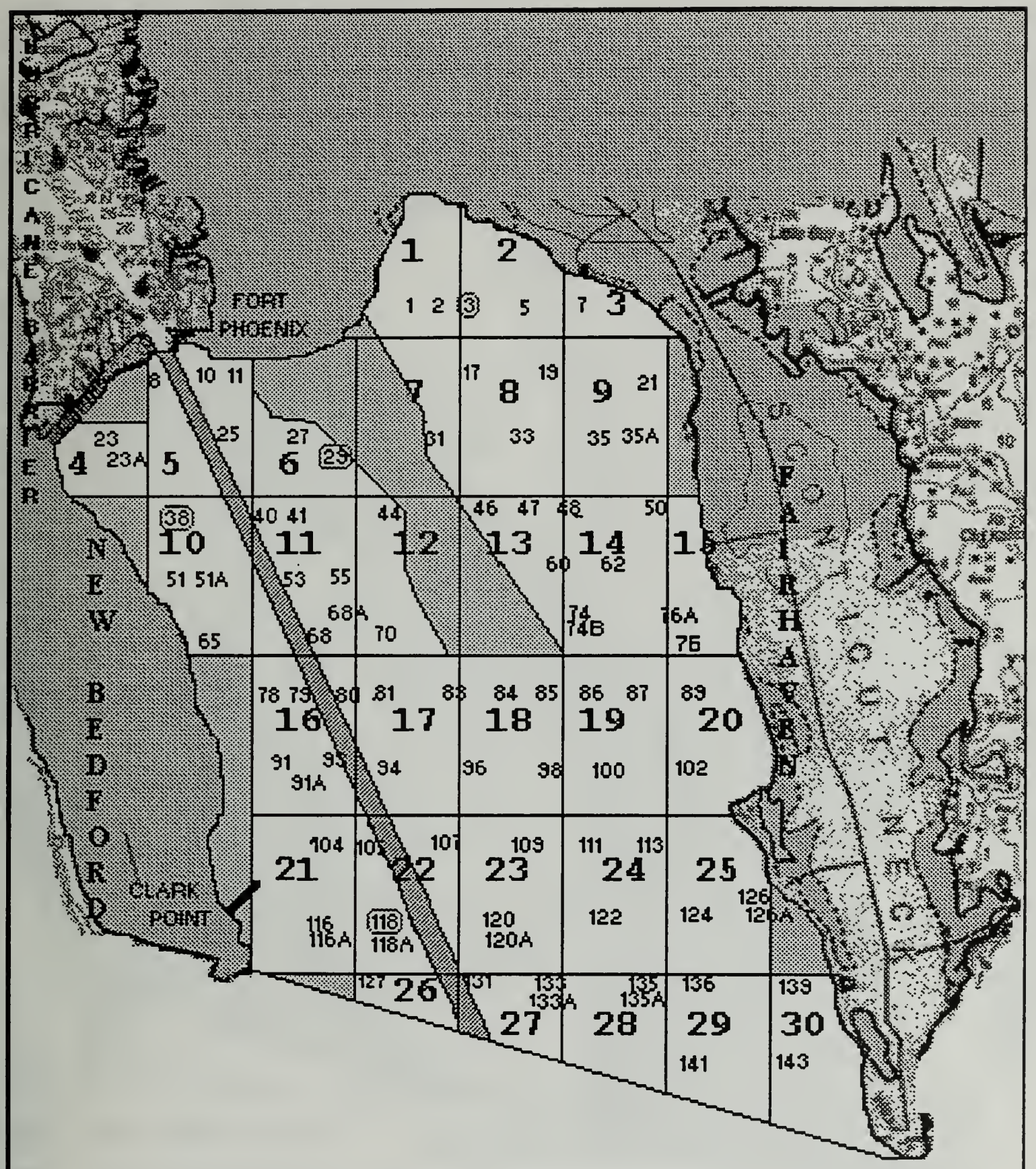
NEW BEDFORD INNER HARBOR QUAHOG STANDING CROP SURVEY

STANDING CROP BY SUBAREA (Total Bushels/Subarea)

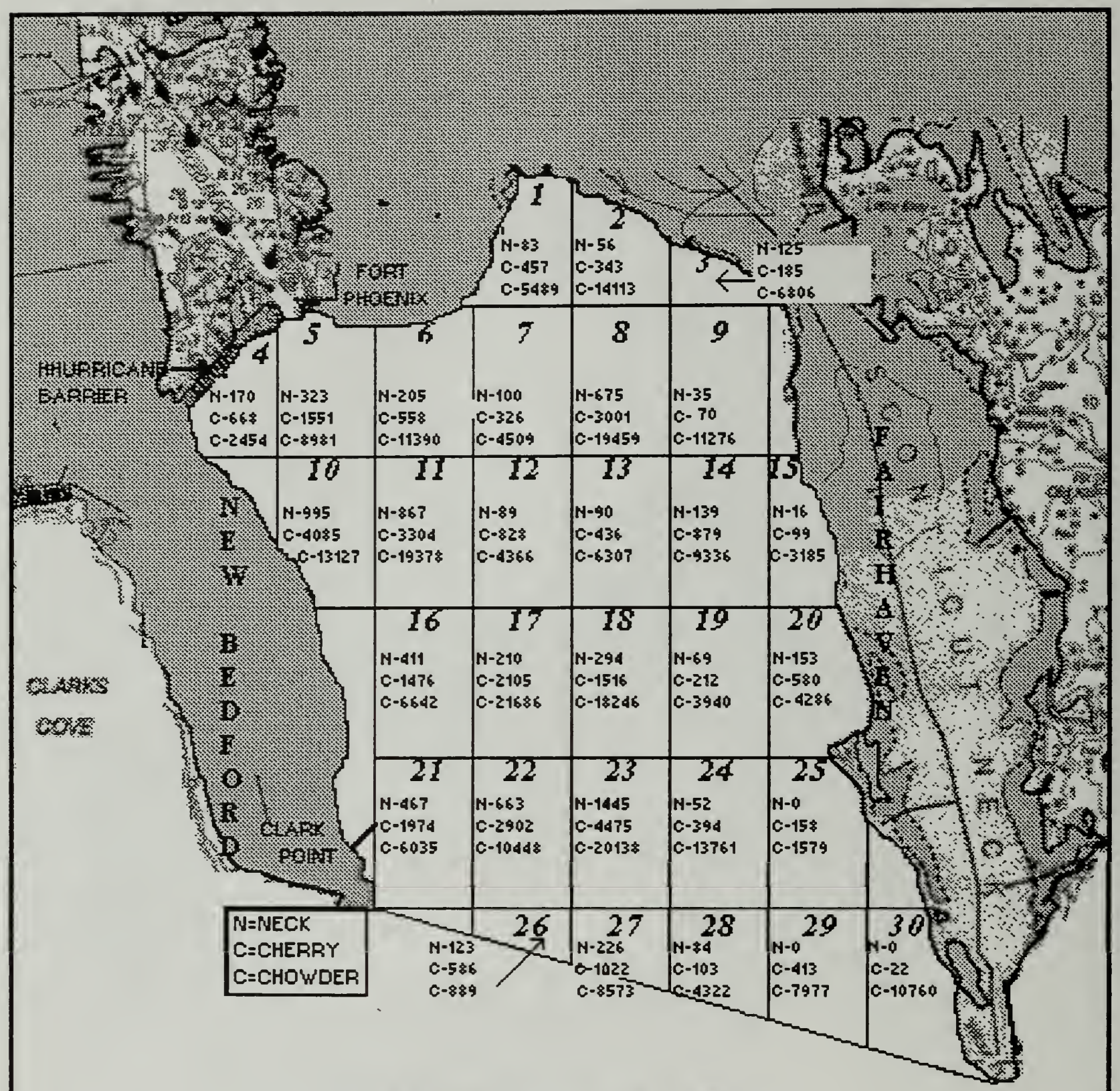


NEW BEDFORD INNER HARBOR QUAHOG STANDING CROP SURVEY

STANDING CROP BY SUBAREA (TOTAL BUSHELS/ACRE/SUBAREA)

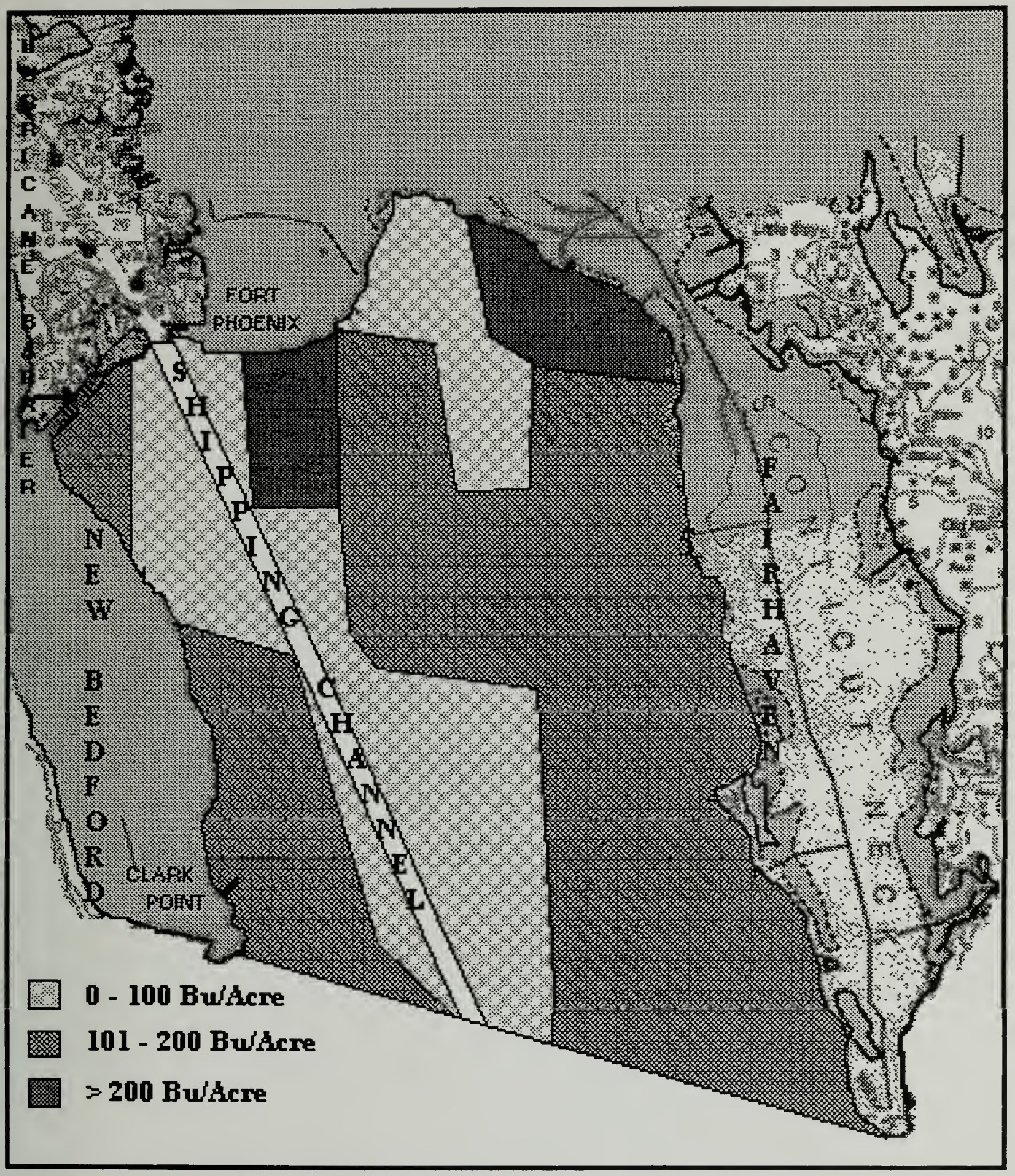


NEW BEDFORD OUTER HARBOR
QUAHOG STANDING CROP SURVEY



Total Bushels per Size Class
Within Subareas

NEW BEDFORD OUTER HARBOR QUAHOG STANDING CROP SURVEY



New Bedford Outer Harbor
Distribution of Quahog Crop

APPENDIX E

Massachusetts Division of Marine Fisheries
Annisquam River Marine Fisheries Station Laboratory
PCB and Trace Metals Collection, Handling and Analysis Procedures

Sample Collection and Handling Procedures for PCB and Trace Metals Analysis

Sample Collection

Equipment:

Field Sampling tools as required for fishery
Permanent marker
Sample tags, water resistant
Clean plastic bags

Criteria for Accepting Samples

1. At the time the samples are collected, whether by trawl, pot, or clam fork, they should not be mutilated in any way. (eg. breaking of shells or cutting the samples open)

2. Ensure that the sample is superficially cleaned of any sediment or foreign substance by rinsing in nearby seawater from which the sample was collected. This is especially critical for all shellfish samples.

3. Samples for <u>both metals and PCB's</u> from each sample site are placed in a clean dry plastic bag and sealed in a way so that no contamination from outside sources occurs.

4. Sample bag should be labelled directly on the outside of the bag or by a tag affixed to the bag, and also by a tag on the inside of the bag.

5. Bag is labelled using a unique collector ID number which identifies the sampler, the sample site, number and type of sample, and the date of collection.

6. Field records also include a log sheet which in addition to the information from step 5 includes the shippers name, the collectors name, analysis requested, sample condition (eg. fresh or frozen), the agencies involved, contact person responsible for requesting sample analysis w/phone number, and the date and signature of those receiving and confirming the delivery of the samples.

7. Fresh samples are placed in a cooler and delivered to the analyzing lab as soon as possible or frozen until time of delivery.

Corrective Action when sample integrity has been compromised

8a. Note any departures from the preceding criteria in the log book along with the

date and initials of reporting person and advise the shipper, if present, that the samples cannot be accepted for analysis.

8b. Notify the immediate supervisor who will contact and advise the responsible agency/program person requesting the analysis of the problem(s). The agency/program contact person is responsible for remediating any problems with sample integrity, such as providing background information about the sample collection or shipping method that explains any departures from the criteria that will allow analysis and/or by providing new samples.

8c. The samples will either be 1) retained until sufficient information about sample integrity is provided that allows subsequent analysis or 2) discarded and replaced with new samples after consultation with the requesting agency/program person.

8d. Unacceptable samples receive laboratory tracking numbers. All information about the samples, such as copies of chain of custody forms, copies of field identification tags, etc. are retained until the final disposition of the samples is resolved after consultation with the requesting agency/program person.

8e. An explanation of the reason(s) for rejecting any samples is entered into the log book. The immediate supervisor provides a brief description in the log book w/date and initials of contact with the requesting agency/program person and corrective action taken by the immediate supervisor thereafter.

Sample Preparation

Reagents:

Acetone; J.T. Baker, Resi-analyzed grade
Hexane; J.T. Baker, Resi-analyzed grade
Deionized water; Type 2

Equipment:

Stainless steel fillet knives
Stainless steel shucking knives
Cutting boards
Stainless steel surgical scissors
Stainless steel spatulas
Stainless steel blender cups
Blender
Surgical scalpel with replaceable blades
Stainless steel tweezers
Aluminum foil
Whirl-Pac bags

Permanent Marker
Squeeze bottle for deionized water

At the time of delivery to the lab, the samples are logged in by laboratory personnel and assigned a sample I.D. number in the sample log book. At this time the samples may either be prepared for analysis or frozen until a later date.

Equipment Preparation

NOTE: Whenever solvents are involved, lab personnel should always wear protective labcoats, gloves, and eyewear. Work should also be performed in a fume hood. Knives should be sharpened and cleaned of <u>all</u> shavings and residue before they are solvent rinsed.

1. <u>All</u> stainless steel equipment coming into contact with the samples, including the blender cups must be thoroughly rinsed once with acetone and twice with hexane and allowed to air dry in the hood.

2. After drying the blender cups should have their lids replaced and all other equipment should be stored in solvent rinsed aluminum foil until time of use.

3. Cutting boards should be covered by <u>at least</u> two layers of solvent rinsed aluminum foil.

4. Solvent rinsed aluminum foil packets are to be made for storage of samples for PCB analysis. Two sizes are needed depending on whether tissue or livers are to be stored.

5. At this time the samples are ready to be prepared.

Sample Preparation

<u>For Flounder</u>

Note: Gloves are not to be worn while excising the liver because of the risk of contamination. Gloves are recommended for fileting, but do not let them come in contact with the tissue to be analyzed. Two persons are highly recommended for this part of the procedure.

1. Specimens are allowed to moderately thaw and rinsed with water to remove the mucous-like layer on the outside of the fish.

2. Sample is laid on the foil covered cutting board.

3. The liver is carefully removed using the rinsed scalpel and surgical scissors, being very careful not to puncture or rupture any of the surrounding organs.

4. The liver is then placed in a solvent rinsed tared foil packet. Seal the packet, reweigh and write the sample number and liver weight on the outside of the packet.

   Note: Sample ID should be written both on the front and the back of containers in permanent marker to prevent sample discard should one number become unreadable.

5. The remaining sample is placed on a second covered cutting board and filleted.

6. Place the liberated tissue into the rinsed blender cup, being sure to get the tissue off of the walls and into the bottom of the cup.

7. Blend the sample until it is thoroughly homogenized scraping sample to bottom of cup with stainless steel spatula as needed.

8. After blending, weigh out half of the sample, for metal analysis, into a Whirl-pac bag and write the sample number and weight on the bag. Weigh out the other half for PCB analysis into a solvent rinsed foil packet and write the sample number and weight on the outside.

   NOTE: Sample ID should be written both on the front and the back of containers in permanent marker to prevent sample discard should one number become unreadable.

9. Take the set of samples for metals and place them together in a freezer. Do the same for the PCB samples.

For Lobster

NOTE: Gloves are worn for lobster preparation being extremely careful to prevent any contact with the sample.

1. Lobsters are to be thawed slightly, but keep the tissue fairly solid to keep any fluids from escaping.

2. Using solvent rinsed surgical scissors, stainless steel spatulas, and tweezers, remove all edible tissues from the sample, including the tomalley.

3. Place all tissues and body fluids from that sample into a solvent rinsed blender cup and blend until it is a semi-fluid mixture. Scrape sample to bottom of cup

as necessary during blending.

4. Weigh out half of the sample into a Whirl-pac, weigh, and label the sample with it's number and weight on the front and back of container. Weigh out the rest into a solvent rinsed foil packet, weigh, and label with sample number and weight.

   Note: Sample ID should be written both on the front and the back of containers in permanent marker to prevent sample discard should one number become unreadable.

5. Separate the samples for PCB's and metals and place them in the freezer for later analysis.

NOTE: When compositing any finfish or lobster the combined sample material is homogenized together in one blender cup. Do not exceed the blender cup capacity of approximately 450 - 500g.

<u>For Shellfish</u>

NOTE: When compositng shellfish each individual in the composite is treated as described below.

1. Allow the samples to thaw slightly before opening.

2. Using a solvent rinsed shucking knife, carefully cut the sample open.

3. Once the shell is open, rinse any sediment from the sample tissue by using a squeeze bottle of deionized water.

4. After all sediment is cleared, proceed to shuck the sample into a solvent rinsed blending cup, being sure to get the tissue off of the walls and into the bottom of the cup.

5. Blend the sample until it is thoroughly homogenized scraping the sample to the bottom of the cup with a stainless steel spatula as needed.

6. After blending, weigh out half of the sample into a Whirl-pac bag, and weigh out the other half into a solvent rinsed foil packet. Write the sample number and weight on both sides of the container in permanent marker. Store the samples in a freezer until sample is needed for analysis.

Trace Metals Labware Cleaning Procedure

Reagents:

Nitric acid; J.T. Baker, Instra-Analyzed Grade
Deionized water; Type 2

Supplies:

Polyethylene Tank for soaking labware in 2% nitric acid
Terge-A-Zyme
Plastic dishpans
Carboys and squeeze bottles filled w/deionized water
Polyethylene drying rack
Tap water

Personal Protective Gear consisting of laboratory coat, gauntlet type gloves (not the disposable gloves), and protective eyewear shall be worn at all times during this procedure.

1. Soak all labware, whether new or used, in Terge-A-Zyme solution for at least 12 hours.

2. Thoroughly rinse labware three times in tap water to remove soap residue.

3. Rinse one time in deionized (DI) water.

4. Soak in 2%v/v nitric acid (Baker Resi-Analyzed Grade in DI water) for at least 12 hours.

5. Thoroughly rinse labware three times with DI water.

6. Air dry on drying rack or open end down on paper towel covered lab bench set aside for this use.

7. When items are dry they are to be stored as follows:

   All bottles shall be stored with lids on. All volumetric flasks shall be stored with glass stoppers inserted with glassine paper or Kim-Wipe strip to prevent "freezing" of the stoppers. All other items to be stored in the assigned drawer or glass-fronted cabinet.

Note: Metal objects, such as blender cups, shall be treated as in steps 1, 2, and 5 through 7. Under no circumstances shall they be placed in the acid bath.

Trace Metals Extraction Procedure and Quality Control

Reagents:

Nitric acid; J.T. Baker Resi-Analyzed grade
Deionized water; Type 2
Hydrogen Peroxide, 30%; J.T. Baker, Baker Analyzed A.C.S. grade

Supplies:

Laboratory coat
Powder-free nitrile or vinyl disposable gloves
Protective eyewear
Ceramic spatulas
Disposable 50mL polyethylene centrifuge tube
Racks for centrifuge tubes
Pan balance, weighs to 10mg
Water bath
Labindustries Repipet Dispenser, 0-10mL model
Ice bath, as needed during hot weather
Reeve Angel grade 508 or equivalent 12.5cm prefolded filter paper
Funnel
50mL class A volumetric flask
Label tape
Squeeze bottle

This extraction procedure is used to prepare samples for analysis for Cd, Cr, Cu, Pb, Zn, and Hg. The tissue types are edible portions of lobster, flounder, and bivalve molluscs.
Each step of the extraction procedure shall be recorded in the extraction log as it occurs.

All information relating to the extraction of samples shall be recorded in the appropriate extraction log book (bound by stitching through spine, pages prenumbered on both sides) in ink. Any changes shall be made by crossing out the errant data and replacing it. Recorded information shall include sample identification, weights, volumes, machine readings (concentration of digestate), each of the digestion steps as performed, and any other pertinent information (comments on reaction progress, condition of samples, etc.). Everything entered into the digestion log book shall be dated and initialed as it is entered into the log book. It is preferred that too much information be recorded rather than too little.

1. Personal protective gear consisting of a lab coat, powder-free nitrile or vinyl gloves, and protective eyewear are to be used throughout. Labware used for

this extraction shall be acid cleaned according to the labware cleaning procedure.

2. Measure 5g of fresh frozen tissue into a 50mL disposable polyethylene centrifuge tube. Standard Reference Material (SRM) tissue weight is 1.00g.

3. From this point until otherwise noted all steps are to be performed in a fume hood. Add 10mL concentrated nitric acid to all tubes including blank, spiked blank, and Hg calibration standard tubes. Note that in the summer the samples may react vigorously to the addition of the nitric acid. To prevent a runaway reaction the samples should be placed in an ice bath for several hours.

4. Leave samples in fume hood at room temperature for approximately 48 hours. Note that room temperature may vary seasonally. For example, in the winter the reaction may be quite slow while an ice bath (as above) may be required in the summer.

5. Place samples in a water bath and bring to 50-55°C for 6 hours. At end of work day turn off bath but leave samples in the bath overnight.

6. Bring water bath to 70-75°c for 6 hours. At end of work day turn off bath but leave samples in bath overnight.

7. Add 5mL of 30% hydrogen peroxide to all tubes. Leave in hood at room temperature for approximately 24 hours. Note: heating samples at this point may cause a vigorous reaction resulting in the loss of digestate.

8. Place samples in room temperature water bath and slowly bring to 55-60°c, pause at any temperature at which reactions appear to be occurring to prevent a runaway reaction. Heat the samples until degassing stops then remove from heat.

9. Filter samples into labeled 50mL volumetric flasks as follows:

   Heat sample to 50-55°C. Filter through Reeve Angel grade 508 12.5cm prefolded filter paper, or equivalent, into volumetric flask. This removes any waxes formed during the digestion and any insoluble particles such as the sand and mud found in shellfish digestate. Rinse centrifuge tube thoroughly with warm (35-40°C) deionized (DI) water three times. Add these rinses to volumetric through the filter paper. Rinse filter paper into volumetric. Remove the filter paper and rinse the funnel into volumetric. Take care not to exceed the 50mL volume. Stopper volumetric and set aside on laboratory bench or cart to

cool to room temperature.

10. When samples come to room temperature make to volume with room temperature DI water. Transfer samples to 125mL screw cap high density polyethylene bottles for analysis.

Trace Metals Extraction Quality Control Criteria

QC Criteria for defining a sample set

1. A sample set shall be comprised of all sample(s), blanks, blank spikes, sample replicates, sample spike(s), standard reference materials (SRM), and any calibration standards requiring extraction (e.g., mercury calibration standards) that are extracted at the same time or step in the extraction procedure.

2. Sample replicates and sample spike(s) comprise at least 10% of the sample load. Finfish and lobster replicates consist of two (replicate) samples. Bivalve mollusc replicates consist of three (triplicate) samples.

3. There shall be at least three blanks and three blank spikes per sample set.

4. SRM type shall be chosen to be as representative of the tissue(s) being digested as possible.

5. At least two replicates of two different SRMs are to be included in each sample set.

6. Concentrations of spiking solutions shall be chosen in such a way that the final volume of digestate contains a spike concentration equivalent to the expected mean concentration of the analyte in that tissue type. Refer to the "Trace Metals Extraction Spike Solution Procedure." Under no circumstances shall the final spike concentration be below the detection limit of the <u>least</u> sensitive analytical device.

QC Criteria for extracting samples

> <u>NOTE</u>: Whenever a sample falls under any of the following criteria each occurrence shall be entered in the extraction log book along with a brief description of the circumstances/nature of the problem, any corrective action taken, date of occurrence and initials of the person reporting the problem.

1. Samples exhibiting an overly vigorous reaction shall be rejected and reextracted. This includes samples which boil or boil out of extraction containers, eject tissue or digestate from the extraction container, melt the extraction container, or burst the extraction container.

2. Samples in a defective extraction container shall be rejected and reextracted. This situation is evidenced by an unusual fluid level in the extraction container due to the intrusion of water from the water bath or leakage of digestate out of the extraction container. Samples stored after extraction in a bottle that is or becomes defective

shall be rejected and reextracted.

3. Samples from which digestate has been lost due to spillage shall be rejected and reextracted. Samples spilled during subsequent analysis after being made to volume shall be discarded and reextracted if there is not sufficient digestate to complete all requested analyses.

4. Samples whose digestate turns brown or black shall be rejected and reextracted with care to assure adequate acidification of sample.

5. Samples whose final volume is questionable shall be rejected and reextracted. This includes samples overfilled during the filtering process.

6. Samples contaminated in any way shall be discarded and reextracted.

Trace Metals Extraction Spike Solutions Procedure

The different tissue types contain different mean concentrations of the various elements, for example, lobster tissue contains more copper than either flounder or shellfish. For this reason each type of tissue must have its own spiking solution(s). The sample/blank spike solutions shall be made to contain all noninterfering (e.g. coprecipitating) elements in one solution. This minimizes the number of spike solutions added and thus the chances for contamination. It also decreases interference with the digestion because of dilution of the acid.

1. The concentrations in the following spike solutions have been found to be consistent with the QC criteria described above for 5g of fresh frozen tissue digested and made to a final volume of 50mL.

	Lobster	Flounder	Shellfish
Cd	2.5ppm	2.5ppm	2.5ppm
Cr	5.0ppm	5.0ppm	5.0ppm
Cu	250.0ppm	50.0ppm	10.0ppm
Pb	20.0ppm	20.0ppm	20.0ppm
Zn	250.0ppm	50.0ppm	100.0ppm

2. Mercury spike solution concentrations are dependant upon the volume of digestate used in the analyses as well as the total volume of digestate and the weight of the sample digested. For this laboratory the values routinely used are as follows:

   Tissue weight: 5g
   Digestate volume: 50.0mL
   Aliquot analyzed: 5.0mL

   Under these conditions the samples are spiked as followed:
   Lobster: 0.5mL of 1.0ppm Hg
   Flounder: 0.5mL of 1.0ppm Hg
   Shellfish: 0.5mL of 1.0ppm Hg

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3. The above spiking solutions will result in the following spike concentrations under normal circumstances (50.0mL final volume of digestate, 5.0mL aliquot used for Hg analyses).

	Lobster	Flounder	Shellfish
Cd	0.05ppm	0.05ppm	0.05ppm
Cr	0.10ppm	0.10ppm	0.10ppm
Cu	5.00ppm	1.00ppm	0.20ppm
Pb	0.10ppm	0.40ppm	0.40ppm
Zn	5.00ppm	1.00ppm	2.0ppm
Hg	50.0ng/aliquot	50.0ng/aliquot	50.0ng/aliquot

Standard Reference Material Acceptance Criteria

Values for the following Standard Reference Materials (SRMs) are accepted if they fall within the ranges defined below. Ranges are expressed as % recovery of the mean value for the element as it appears on the certificate accompanying the SRM.

	NIST 1566a[1]	TORT-1[2]	DORM-1[3]
Cd	80.0-120.0%	80.0-120.0%	80.0-120.0%
Cr	30.0-140.0%	50.0-135.0%	50.0-120.0%
Cu	80.0-120.0%	80.0-120.0%	80.0-120.0%
Pb	70.0-120.0%	70.0-120.0%	60.0-140.0%
Hg	80.0-120.0%	80.0-120.0%	50.0-120.0%
Zn	80.0-120.0%	80.0-120.0%	80.0-120.0%

1. National Institute of Standards & Technology; SRM 1566a, Oyster Tissue.

2. National Research Council Canada (NRCC); Lobster Hepatopancreas Marine Reference Material for Trace Metals and Other Elements.

3. National Research Council Canada; Dogfish Muscle Certified Reference Material for Trace Metals.

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Trace Metals Data Handling and Quality Control Procedure

In addition to the quality control measures taken during the preparation, extraction, and analysis of the samples the following measures are to be applied to the data analysis of the instrumental results. The data processing is performed using spreadsheets in Quattro® Pro (Borland International, Inc.). The spreadsheets were designed and created in-house by a member of the chemistry staff.

1. After the samples have been analyzed and the results as printed on the PR-100 printout (machine readings or machine values) have been accepted, the values are to be transferred to the appropriate place in the extraction log book.

2. Before being entered into the spreadsheet(s), all data in the extraction log book is to be checked for accuracy.

3. Each spreadsheet is to be given a unique alphanumeric name according to the current practices of the chemistry group.

4. After the data is entered into the spreadsheet(s) it is to be checked for accuracy before being printed as a hard copy.

5. All data in the spreadsheets is to be saved on a clearly labelled computer diskette.

6. All data on diskette is to be backed up on a second clearly labelled diskette.

7. After the results of the calculations have been printed to hard copy they are to be checked for accuracy and results which seem unusual or are otherwise suspect (see Trace Metals Instrument Operating Procedures and Data Quality Control Procedures).

Trace Metals Instrument Operation Procedures and Data Quality Control

Atomic Absorption Spectrophotometer

The following quality control criteria apply to the Perkin Elmer (PE) 3030B Atomic Absorption Spectrophotometer (AAS) and all the accessories as of 01/01/95. These accessories are the PR-100 printer, MHS-10 manual mercury hydride generator, the HGA-400 graphite furnace, and the AS-40 autosampler and autosampler controller for the HGA-400.

The instrument log book is a stitched bound book in which all pages are printed with consecutive page numbers. All information shall be entered into this book in ink. Any changes shall be made by crossing out the errant information and writing the correct information in as close as possible to the original. All information entered into the instrument log book shall be dated and initialed.

1. At start up check to be sure the correct software disk is in use.

2. There is a machine problem if any screen is slow to come up, fill in, or update when the machine is being set up for analyses. There is also a problem if the wrong screen appears during set up of the AAS. Any problem(s) shall be recorded in the instrument log book and the Chemist III shall be notified.

3. During machine set up the following information shall be entered into the instrument log book. The element to be analyzed, the method of analysis (flame, graphite furnace, etc.), lamp energy without background (BG) corrector on, and lamp energy with BG on. In flame mode the following shall also be recorded, fuel and air pressure as indicated on the AAS control panel, concentration and maximum absorbance of the sensitivity check solution both with and without the BG on, and the characteristic concentration of the sensitivity check solution both with and without the BG on. When the furnace is in use the additional information shall consist of the minimum absorbance attained with and without the end windows in place without the BG on as well as the minimum energy with the windows and BG on. When using the MHS-10 the additional information shall consist of the minimum absorbance attained with the quartz tube in the lamp path with and without the BG on.

4. After recording the set up information (see 3) in the instrument log book, the current information shall be checked with the values recorded for earlier similar (i.e. same element, same method of analysis) analyses. Any values not within 5% of earlier values indicates a problem either with the set up procedure or with the equipment. The set up procedure shall be checked (please feel free to ask for assistance in this). If no problems are found with the set up after consultation with other users it shall be assumed that there is a machine or supplies (e.g. lamp, graphite tube, windows, quartz tube, flash arrester, etc.) problem. This problem shall be

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recorded in the instrument log book and the Chemist III shall be notified. If there is a problem with the supplies they shall be repaired or replaced if possible and the machine reset up and retested.

5. Calibration standards shall be chosen so as to encompass the expected range of sample values and to remain within the linear range for the chosen method (Flame AAS, Furnace AAS, etc.) of analysis. Achieving this may require some samples to be analyzed by more than one method for a particular element.

6. The calibration curve shall be entered into the AAS using the chosen calibration standards (see 5), the stability and precision of the curve shall be checked by rereading the calibration standards as "samples". If the curve is nonlinear, if the zero value is significantly different than zero, and/or if either of the end standards is not linear the curve shall be reentered into the AAS and rechecked. Should the problem persist the machine set up shall be checked to assure that the chosen method and the method set up are the same. If the curve continues to fail the check the standards shall be checked for accuracy and any faulty, contaminated, or otherwise suspect standards shall be replaced. If the problem continues it may be a machine or supplies (see 4) problem, the problem shall be noted in the instrument log book and the Chemist III shall be informed. If the problem is with a supply, it shall be corrected if possible and the machine shall be reset up and retested.

7. After successful completion of the curve check as in step 6, the calibration curve shall be checked for accuracy by reading as samples at least two U.S. Environmental Protection Agency Water Pollution Laboratory Performance Evaluation Study (EPA WP series) samples. These samples shall be chosen to be representative of the curve, at least one shall be of low concentration and one of high if possible. If these samples deviate from their expected values by more than 10% the curve shall be rejected and reentered as above. If the calibration curve again fails at this step the operator shall recheck the machine set up and continue with steps 6 and 7. Should the curve again fail to pass step 7 the Chemist III should be consulted and the information recorded in the instrument log book. The supplies such as the lamp, the sampling capillary, the graphite tube, etc. shall be checked for wear or failure and replaced if possible, this shall be recorded in the instrument log book. The machine shall be rechecked for correct operation.

QC Procedures: Flame AAS analysis

8. Each of the blanks and blank spikes are analyzed three times; at the beginning of the analysis, midway through the sample set, and at the end of the sample set.

9. Each of the Standard Reference Materials (SRMs) are analyzed three times as above.

10. The baseline is to be monitored for drift or any other erratic behavior. If the baseline becomes suspect the zero calibration solution is to be run as a sample immediately. If the baseline has shifted it is to be reset and all the calibration standards are to be run as samples. If the curve has shifted due to the change in baseline it is to be reentered and checked as in 7 above. If the baseline continues to drift more than expected the lamp energy should be monitored for erratic behavior (possible bad or worn lamp), the sample capillary shall be checked for crimping or blockage, and the drain tubing shall be checked for proper drainage. If any of these are the problem they shall be replaced or repaired if possible. This shall be recorded in the instrument log book and the equipment shall be rechecked for proper operation.

11. The zero calibration solution is to be checked at least every ten samples. If excessive drift has occurred it shall be treated as in 8 above.

12. One of the calibration solutions is to be run at least every ten samples. If the value is more than 10% different than the expected value the entire curve shall be checked for drift. If the curve has shifted it shall be reentered and checked as in 6 and 7 above. If excessive drift occurs due to environmental conditions such as room temperature or electrical fluctuations it may be necessary to suspend analyses until the conditions improve. If this occurs it should be noted on the PR-100 printout and in the instrument log book.

13. At least one of the EPA WP series samples is to be run at least three times during the analysis of a sample set. If the sample value deviates from the expected by more than 10% the calibration solutions are to be checked immediately and treated as in 6 and 7 above. If the calibration standards pass and the EPA WP series sample continues to fail another EPA WP series sample shall be checked. If the second EPA WP sample passes it can be assumed that the first is faulty in some way and the first EPA WP sample shall be disregarded in favor of the second. This shall be noted on the PR-100 printout at the position of the change. The analyses of samples may be continued under these circumstances. If the second EPA WP series sample also fails the calibration curve is suspect and shall be checked as in 6 and 7 above.

14. The curve should be checked as in 11, 12, and 13 above whenever the operator suspects a problem.

15. The samples are to be run to produce triplicate readings taken consecutively, that is, with no removal of the sampling capillary between readings of concentration. Should the three readings vary more than expected for that sample type, element, and concentration (samples near the detection limit generally have a larger relative standard deviation) the AAS should be checked as in 11, 12, and 13 above. If there is no problem with the machine or the curve the large standard deviation shall be considered an artifact of the sample.

16. Each of the blanks and blank spikes is to be run at least three times. If the samples occupy three or more autosampler trays the blanks and blank spikes shall be run once in each tray. If they are less than three trays of samples then run the blanks and blank spikes as described under Flame AAS procedures above.

17. Each of the SRMs are run at least twice per sample set.

18. The zero calibration solution shall be repeatedly run at the beginning of an analysis until a stable baseline can be established. This removes any airborne contaminants which may have settled in the furnace as well as any which have settled on the sampling capillary or in the rinse out cup. It may be necessary to replace the zero calibration solution if any contaminants are introduced by this procedure.

19. The first sample positions in the sample carousel shall contain all of the calibration standards. These shall be used to check the precision of the calibration curve. Should any or all of these values vary from the expected by more than 10% the curve shall be reentered and rechecked. If this problem persists the calibration standards shall be checked for contamination, improper concentration, or contamination of one or more sample cups. The appropriate corrective action shall be taken. If none of these are the problem the operator should check the temperature program, in particular the atomization temperature should be checked. Additionally, the sampling and rinse pumps and capillaries, rinse drain tubing, position of the sampling capillary in the graphite tube and sample cups, and operation of the sampling arm are to be checked for proper operation and corrected if possible. If the problem is with the equipment or supplies the Chemist III should be notified immediately, if the problem can not immediately be corrected any furnace analysis shall be suspended. Any repairs or need for repairs shall be entered into the instrument log book.

20. A zero calibration standard shall be placed in carousel spots number 10, 20, and 30. A calibration standard other than zero shall be placed in carousel positions 11, 21, and 31. An EPA WP series standard shall be place in positions 13, 23, and 33. An EPA WP series sample shall also occupy the carousel position immediately after the check calibration samples discussed in 19. These samples are used to check the accuracy, precision, and drift of the curve. If the accuracy or precision are more than 10% different than the expected value the corrective actions specified in 19 shall be applied. If the drift is more than 10% the recalibration function of the furnace shall be utilized.

21. Any sample found to be higher than expected from the flame analysis shall be checked for contamination in the furnace sample cup. The sample shall be replaced with a new aliquot in a new sample cup. Note that samples near the detection limit of the flame technique may be higher than expected if the flame analysis had a noisy

baseline.

22. Any analyses found to be suspect shall be disregarded and rerun. Analyses are suspect if they exhibit a trend of increasing or decreasing concentration or the concentration values of the QC samples are erratic.

QC Procedures: Hydride System AAS analysis

23. The blanks are identical to the zero calibration solution and the blank spikes are identical to the calibration standards. Run the blanks and blank spikes as described above in the instrumentation procedures section.

24. The SRMs are to be individually spaced and run throughout the analysis of the set. One SRM is run after the calibration curve is accepted and one at the end of the set. Other SRMs are used if the curve is recalibrated or after a long pause in the analysis. Each individual SRM is to be run at least once during the analysis of the sample set.

25. The value of the baseline shall be continuously monitored. If the value of the baseline becomes suspect it shall immediately be checked with the zero calibration solution. If the baseline has drifted two or more units from zero it shall be reset and a calibration standard shall be run. If the calibration standard varies more than 10% from the expected value the curve shall be reentered and checked for precision. If the problems persist the equipment shall be checked for poor or erratic lamp energy, a partially or fully blocked flash arrester, a partially or fully blocked reductant capillary, and/or fluid in the quartz tube or gas transfer tubing. If any of these problems occur it shall be noted on the PR-100 printout, additionally, any lamp or AAS problems shall also be noted in the instrument log book. Any problem with equipment or supplies shall be fixed if possible and the analysis resumed after the calibration curve is reentered and checked. The Chemist III shall be notified regardless of the outcome of the repair attempt.

26. The curve shall be checked as in 25 at any time that the analysis becomes suspect. The analysis is suspect if the triplicate readings of a sample vary by more than a few units, one of the sample readings is more than a few units different from the other two readings, the samples show a pattern of increasing or decreasing concentration, the lamp energy is observed to fluctuate or change, or the background values become erratic or different.

Quality Control Criteria for Instrument Data Analysis

QC Criteria for blanks, blank spikes and SRMs

NOTE: Any of the following problems are to be properly noted in the extraction log book.

1. Any blank whose value is suspect shall be rejected and not included in the data processing. A blank is suspect when values for any or all elements are larger than the mean plus three times the standard deviation of the remaining blanks.

2. Any blank contaminated at any time during analysis shall not be used for that analysis or any subsequent analyses and shall not be included in the data processing.

3. Any blank spike whose value for all elements is the same multiple or fraction of the expected value shall be discarded and not used in any analyses, it shall not be used in the data processing.

4. Any blank spike whose value is outside the range of the expected value plus or minus 20% shall be rejected and not included in any calculations.

5. Any blank spike which is contaminated during analysis shall be discarded and shall not be used for that or any subsequent analyses. It shall not be used in the data processing.

6. Any reference material whose value for all elements is the same multiple or fraction of the expected value shall be discarded and not used in any analyses. It shall not be used in the data processing.

QC Criteria for elements within a sample set

7. If more than one blank in the set is rejected for an element the values for that element shall be disregarded and not used in the data processing. The samples shall be reextracted and retested for that element.

8. If more than one spike blank in the set is rejected for an element the values for that element shall be disregarded and not used in the data processing. The samples shall be reextracted and retested for that element.

9. If more than one or 10%, whichever is higher, of the tissue spikes in the set is rejected for an element the values for that element shall be disregarded and not used in the data processing. The samples shall be reextracted and retested for that element.

10. If more than one of each of the Standard Reference Materials in the set is rejected for an element the values for that element shall be disregarded and not used in the data processing. The samples shall be reextracted and retested for that element. For rejection criteria see chart.

QC Criteria for an entire sample set

11. If more than one blank in the set is rejected for 50% or more of the elements the set shall be disregarded and not used in the data processing. The samples shall be reextracted and retested.

12. If more than one blank spike in the set is rejected for 50% or more of the elements the set shall be disregarded and not used in the data processing. The samples shall be reextracted and retested.

13. If more than one or 10%, whichever is higher, of the tissue spikes in the set is rejected for 50% or more of the elements the set shall be disregarded and not used in the data processing. The samples shall be reextracted and retested.

14. If more than one of each of the Standard Reference Materials in the set is rejected for 50% or more of the elements the set shall be disregarded and not used in the data processing. The samples shall be reextracted and retested. For rejection criteria see chart.

% DRY WEIGHT DETERMINATION

Supplies/Equipment:

Disposable Aluminum Weigh Pans
Stainless Steel Spatulas (one per sample)
Drying Oven
Analytical Balance

Note: % Wet Weight is performed at the time of extraction as the sample is thawed only once and the weight value is available for calculations when needed.

1. Using a ball point pen emboss the sample identification number into the aluminum weigh pan.

2. Weigh the empty pan to the nearest 0.1mg and record the weight.

3. Using a stainless steel spatula transfer 0.5 to 1.5g of tissue to the weigh pan and record the weight of pan plus tissue. The weight of the tissue used is dependent upon the amount of tissue available and the tissue type with more fluid samples requiring less tissue. Subtract the pan weight to obtain the tissue wet weight.

4. Place the pan plus tissue in a 60°C oven overnight.

5. Remove sample from oven, let cool to room temperature, weigh the pan plus dry tissue to the nearest 0.1mg, and record the weight. Subtract the pan weight to obtain the tissue dry weight.

6. Percent dry weight is calculated as the weight of the dry tissue obtained in step 5 divided by the weight of the wet tissue obtained in step 3 multiplied by 100:

$$\frac{\text{Tissue Dry Wt. (g)}}{\text{Tissue Wet Wt. (g)}} \times 100$$

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Method for Determination of Percent Lipid Content in Marine Biota

Equipment and Supplies:

Analytical Balance (accurate to 0.1mg)

Beckman Model TJ-6 centrifuge
Drill
Vortex mixer
Stainless steel spatula
Scalpels (if analyzing fish tissue)
9" Pasteur pipettes
Kontes 10mL Homogenizer tube(mortar) with teflon tipped pestle(1 per sample)
1 40mL centrifuge tube per sample
20mL scintillation vial(pre-weighed)
10mL graduated cylinder
25mL graduated cylinder
Teflon Squeeze bottle Dichloromethane(DCM)
Teflon Squeeze bottle Methanol
Distilled water
0.7% NaCl solution

Sample Weight per Tissue Type

Finfish Tissue(finely minced)	0.40g - 1.00g
Finfish Liver	0.25g - 0.40g
Lobster Tissue	0.40 g - 1.00g
Shellfish Tissue	0.40g - 1.00g
Roe or Gonad Tissue	0.40g - 1.00g

NOTE: Make sure that all samples are very well homogenized before analysis for

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lipids. Finfish tissue needs to be finely minced using scalpels before weighing due to its texture.

Glassware does not need to be thoroughly solvent rinsed because the technique is gravimetric. Make sure the glassware is clean and free of lipid residue. You must completely solvent rinse (once with acetone, twice with hexane) any spatula which is to come into contact with the archive sample.

1. Weigh sample into a clean, dry homogenizer tube(mortar).

2. Create a 1:1 sample/distilled water mixture in the homogenizer tube.

3. Using a teflon tipped pestle homogenize the sample for 1 minute moving the pestle up and down to insure complete mixing.

4. To the homogenizer tube, pipette 5mL of a 1:2 DCM/Methanol mixture, making sure to rinse any sample residue from the probe and the side of the tube. (Try and keep this pipette with the sample until step 19)

5. Let stand for 10-15 minutes vortexing the sample every 3-5 minutes.

6. Centrifuge sample for 5 minutes at a setting of between 5 and 6.

7. Prepare 5mL of a 1:1 DCM/Methanol mixture and set aside.

8. Remove supernatant and transfer into the 40mL centrifuge tube.

9. Add the 5mL 1:1 DCM/Methanol mixture to the homogenizer tube.

10. Repeat steps 5 & 6.

11. Prepare 5mL of a 3:1 DCM/Methanol mixture and set aside.

12. Remove supernatant and combine with the previous supernatant in the 40 ml centrifuge tube from step 8.

13. Repeat step 9 using the 3:1 DCM/Methanol mixture.

14. Repeat steps 5 & 6.

15. Remove the supernatant and combine in the centrifuge tube with that from

steps 8 & 12.

16. Add 2.5mL of a 0.7% NaCl solution to each centrifuge tube and reflux with a pipette to insure complete mixing.

17. Place tubes in a refrigerator for 30 minutes.

18. Centrifuge the tubes for 10 minutes at a setting of 6.

19. Carefully remove the bottom DCM layer from the tubes and transfer them to the pre-weighed scintillation vial labelled for that sample.

20. Evaporate the sample under a stream of N_2 until all DCM and possibly a small amount of methanol have evaporated.

21. Re-weigh the scintillation vial and calculate the percent lipid for the sample.

PCB Labware Cleaning Procedures

1. All Labware, including glassware, teflon stopcocks, stainless steel spatulas, tweezers, etc..., will be washed with soap (Liqui-onox) and hot water. For the cleaning of the Tekmar probes, see next section ("Cleaning Procedures For Tekmar Probes").

2. Labware will be rinsed with tap water, followed by distilled water, then all glassware will be dried in a drying oven.

3. After drying:

   - Teflon stopcocks will be stored until just prior to use.

   - Volumetric glassware(pipettes, graduated cylinders, etc...) and chromatography columns will be capped with aluminum foil and stored.

   - All other glassware will be capped with aluminum foil and baked at 400°C for two hours in the muffle furnace.

4. **Prior to use, <u>ALL</u> glassware and lab equipment will be thoroughly solvent rinsed. <u>Rinse once with acetone and then twice with hexane.</u>**

Cleaning Procedures for homogenizer Probes

1. Immediately after use, probes will be run at high speed in a solution of water and Liqui-nox to prevent tissue material from drying on the probe.

2. Probes will then be disassembled and washed in hot soapy water. All parts are then rinsed with tap water followed by distilled water. Rinse once with acetone to prevent rust on probe parts and then allow to dry.

3. The inner stem and outer sleeve are solvent rinsed (once with acetone and twice with hexane).

4. Place the remaining small parts in a clean beaker, add acetone, and sonicate for ten minutes in a hood.

5. Decant the solvent and rinse with hexane.

6. Add hexane to the beaker and sonicate for 10 minutes in a hood.

7. Repeat Steps 5 and 6.

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8. Place all clean parts on a piece of rinsed aluminum foil, allow to dry in a hood, and reassemble using solvent rinsed tweezers.

9. Store probes in assigned cleaned, solvent rinsed stainless steel pan, cover pan with solvent rinsed aluminum foil.

10. Prior to using the probe run it at high speed for three minutes in each of the following solvents in this order: acetonitrile, acetone, hexane. Observe the solvents for any small particles that may come off the teflon bearing. Repeat rinse if necessary. Place probe in solvent rinsed aluminum foil until used.

Extraction Procedure for PCBs

Reagents:

Acetonitrile; J.T. Baker, Resi-Analyzed
Hexane; J.T. Baker, Capillary-Analyzed
Saturated Salt(NaCl) Solution; J.T. Baker, ACS grade
Distilled Water

Glassware/Equipment:

6 100mL Glass Centrifuge Tubes
6 Solvent Rinsed Tekmar Probes
6 1000mL Separatory Funnels w/ teflon stoppers & stopcocks (rubber O-ring excluded)
6 Glass filter funnels
6 300mL or 500mL Pear Shaped Flasks w/glass stoppers
Waste Beakers
Tekmar Tissuemizer w/probes
Centrifuge; Beckman, Model TJ-6
Rotary evaporator w/water bath, vacuum pump and coolant system

NOTE: See cleaning procedures for all glassware and probes before use.

Procedure:
Samples are organized into batches of 20. Each batch contains 3 sub-batches. The sub-batches are labeled as A,B, and C accordingly (eg.Batch 1 Subatch A). Each sub-batch contains 8 extractions with QC samples typically as follows:

Sub-batch A - 1 Procedural Blank
Sub-batch B - 1 Sample Replicate
Sub-batch C - 1 Matrix Spike & 1 Laboratory Control Material

1. Add homogenized biota sample to centrifuge tube. Centrifuge tube remains with sample through extraction procedure. Approximate wet weight for different organisms is as follows:

flounder liver	0.25g
flounder tissue	5 g
lobster	3 g
bivalves	5 g
alewife roe	0.5g
alewife tissue, other	5g

2. Measure 50mL acetonitrile in a graduated cylinder and add to centrifuge tube.

   Note: When preparing spiked sample, add 40ng of BZ 198 standard to sample prior to first blending using a syringe. Blanks, matrix spikes and laboratory control marterial receive identical treatment as the samples at all times.

3. Start blending at low speed scraping sample off sides and bottom of tube with homogenizer probe or grinding large tissue pieces into fine pieces with probe as necessary. Once tissue is suspended blend at high speed for two (2) minutes, raise the probe above the acetonitrile but keep it within the tube, rinse any tissue from the probe with a small amount of acetonitrile. Remove probe from tube, place solvent rinsed aluminum foil over the mouth of tube and screw on tube's cap.

4. Centrifuge for 5 minutes @ 2500 rpm (dial setting # 7) and decant acetonitrile into a 1 Liter separatory funnel.

5. Repeat steps 2, 3, and 4 two times.

6. Measure 100mL of hexane in a separate graduated cylinder. Pour the 100mL hexane into the centrifuge tube assigned to the sample to rinse any remaining sample residue and centrifuge for 5 minutes (as in step 4). Add the 100mL hexane to the 1L separatory funnel when ready to continue.

7. Vigorously shake the 1L separatory funnel for 90 seconds.

   Caution: Vent the separatory funnel once or twice after 1 or 2 initial shakes to relieve vapor pressure and repeat periodically while shaking.

8. Add 10mL of saturated salt solution to the 1L separatory funnel, followed by approximately 500mL distilled water.

9. Hold separatory funnel horizontally and shake for 35 seconds. Remember to vent funnel periodically.

10. Allow phases to separate. Drain lower phase and watch for an emulsion. If an emulsion (foam) is present between phases, attempt breaking up the emulsion with a glass rod (use a separate glass rod for each sample). If emulsion still persists, proceed as follows:

    a. Add another 10mL saturated salt solution, after draining as much of the lower phase as possible without losing any emulsified material. Allow some time for the emulsion to disperse.

b. Drain any water that has been released.

c. Add 100mL distilled water to the separatory funnel and let the phases separate. Drain off lower phase and repeat the procedure 3X. Proceed to step 12.

11. Add 100mL distilled water to separatory funnel. Invert the separatory funnel, carefully open stop cock and gently swirl for 5 seconds. Drain lower phase then repeat the procedure with a second 100mL distilled water.

12. Drain lower phase from separatory funnel. Collect upper phase in a glass stoppered round bottom or pear flask.

13. Rotovap the sample to approximately 50 ml in the flask. Rotational speed is 100 rpm, water bath temp. is 50°C, vacuum is 22 inches of mercury, and coolant system temp. is 1°C.

    Note: Samples can be stored in a refrigerator at this step. Storage over 4 days is in the freezer.

Column Chromatography Cleanup for PCBs

Reagents:

Sodium Sulfate (anhydrous); J.T. Baker, ACS grade
Florisil 60-100 mesh; J.T. Baker analyzed, activated at 650°C, stored at 130°C
Hexane; J.T. Baker, Capillary-Analyzed
Sulfuric Acid; J.T. Baker Analyzed

Glassware/Equipment:

Baked glass wool
Baked GC vials w/250 µl inserts
Nitrogen gas delivery manifold
10 ml concentrator tubes
6 Baked Pasteur Pipettes
6 300mL Chromatography Cleanup Columns w/ teflon stopcocks (rubber O-rings excluded)
6 500mL Round Flat Bottomed Flasks w/ glass stoppers
10mL Graduated Cylinder
250mL Graduated Cylinder
waste erlenmeyer flasks
Vortex mixer
Rotary evaporator w/water bath, vacuum pump & coolant system

NOTE: See cleaning procedures before using any glassware.

1. Wearing dry disposable gloves, i.e, w/o any water droplets from washing glassware, construct the column by placing a glass wool plug, (handling the glass wool with tweezers and a glass rod) at the bottom of the column, assemble stopcock without the rubber o-ring. Place a waste beeaker, 500 ml or larger, under the column. Add 20g Florisil (cool to the touch) and approximately 1/2" of sodium sulfate. Rinse column with 200 ml hexane. Drain off excess hexane but always leave 1/2" of hexane covering the top of the column (Do not let column go dry). Discard the solvent and replace the beaker with a 500 ml flat bottom round flask under the column.

2. Before putting the extract on the column, add a few grams of sodium sulfate to the sample extract and watch to see if all the sodium sulfate forms clumps. If so, add more. Let the extract and sodium sulfate stand no less than 10 minutes but no more than 30 minutes before putting the extract on the column.

Div. Marine Fisheries, Annisquam River Marine Fisheries Station, Gloucester, MA

3. Adjust the flow rate on the column to approximately 5mL/min (or 1mL/12 seconds). As hexane drains from top of column, pipette extract onto column. Do not let the column go dry.

4. Add 10mL of hexane to the empty pear or round bottom flask, rinse sides of flask with 10 ml hexane using the pipette. When the last of the extract disappears from the top of the column, add the 10mL hexane rinse.

5. Repeat the 10mL flask rinse 2X adding the rinse each time to the column as in step 4.

6. After the last 10mL hexane rinse disappears from the top of the column, rinse the column with hexane using the teflon squeeze bottle, and add 220mL hexane to the column. Collect all hexane from the column in the 500mL flat bottom flask.

7. Rotovap the sample to less than 5mL and quantitatively transfer to a 10mL concentrator tube. Rotational speed is 100 rpm, water bath temp. is 50°C, vacuum is 22 inches of mercury, and coolant system temp. is 1°C.

8. Concentrate the sample to less than 1mL under a stream of N_2, and spike with 40ng each of BZ103 and 2,4,5,6-tetrachloro meta-xylene (TCMX) Internal Recovery Standard.

9. Adjust spiked extract to exactly 1mL, acidify by adding 0.5mL H_2SO_4, vortex mix for 30 sec. and place an aliquot of the supernatant in a GC vial for GC analysis. The remaining supernatant is placed in a screwcap GC vial and archived in the freezer.

Operating Procedure for Gas Chromatographic Analysis of PCBs

Read the manuals and the "GC Maintenance and troubleshooting" Section before operating the GC.

Equipment:

Gas Chromatograph:	HP5890 w/electronic pressure control
Detector:	Electron Capture Detector
Auto Sampler:	HP7673
Integerator:	HP3365 Chemstation installed on 80486DX/66mhz
computer	working from Windows for Workgroups v. 3.11.
Printer:	HP520 inkjet

System Pre-Run Check Sequence:

1. Check all gas supplies and pressure; make note of any purifying cartridges (Supelco OM-1) that are spent or are low and will need to be replaced prior to the next run. Make note of any gas tank pressures that are low.

2. Before beginning operation raise the oven temperature to 280°C for approximately 10-20 minutes until a stable baseline is achieved. Return oven temperature to initial setting and make an injection of hexane. When a clean run is achieved proceed with pre-run check and calibration.

3. At initial oven temperature and pressures check all flow rates. Adjust carrier and make-up gas pressure to achieve desired flow rates.

4. Check the temperature and pressure menus to make sure you are running in the desired method and all setpoints have been achieved.

5. Check the autosampler menu to make sure you have three syringe washes and three pumps before injection, one injection per vial, one microliter injection volume (stop #1), and three post-injection washes. Viscosity delay is zero, no "on-column" injection.

6. Check the autosampler menu to make sure the split/splitless purge valve is initially off and is set to come on at the desired time. Make sure the source is assigned to the autosampler at the correct injection port.

Calibration and Run Setup Sequence:

1. In the Sequence menu establish a sequence for multilevel calibration. Create a subdirectory using the current date.

2. Place hexane plus three calibration standards at concentrations of 1, 10 & 40

ppb (or other concentrations as needed to encompass the range of sample values) in the autosampler tray. NOTE: Each calibration standard contains 40 ppb of BZ 103, 198 and TCMX or other concentrations as needed for a particular type of sample. BZ 103 can be omitted if it interferes with the quantitation of peaks of interest. Run the sequence.

3. At the end of the sequence, determine if the calibration meets the QC criteria and replace each level of the calibration table with its' most recent corresponding standard. If the calibration sequence does not meet the QC criteria re-check all gas flows and method menus/parameters. Repeat calibration when system has been checked.

4. After calibrating the method, establish a separate sequence for the sample run and separate subdirectory using the date. Arrange the samples by placing a hexane reagent blank followed by a 10 ppb standard (or other mid-level concentration depending on the range of concentrations in the samples) before the first and after every six samples. When all menus have been checked for accuracy run the sequence.

Gas Chromatograph Temperature and Pressure Programs for PCB Analysis
HP5890 Series II w/pressure programming

Purpose:

This section provides an example of a typical gas chromatograph temperature and program menu and a description of the DB-5/1701 dual column configuration for PCB analysis. The GC operator should review the GC manual and be prepared to make changes in the menu to achieve stable baselines and peak separations or eliminate other problems that may interfere with the identification and quantification of PCBs (refer to the section on GC maintenance and troubleshooting). The menu below serves as a guide only and will change as column conditions change over time and as warranted with different types of samples.

Temperature Setpoints:
Inlet: 275° C
Detectors(A&B): 300° C

Oven Setpoints:
Equilibration Time: 4 min.
Initial Temp.: 100°C
Initial Time: 3 min.

TEMPERATURE PROGRAM

Level	Rate (°C/min.)	Final Temp. (°C)	Final Time (min.)
1	25.00	170	1.00
2	1.0	240	10.71
3	35.0	280	5.00

Total Run Time: 93.65 min.

Flow Setpoints (nominal ml/min.) @ initial temperature and pressure:

	Col. A	Col. B
Total Flow In:	54.20	54.20 (common to both columns)
Total Flow Out:	47.20	48.40
Septum Purge:	2.80	2.80 (common to both columns)
He Carrier:	3.20	2.99
Ar/Me Make-Up:	44.00	45.41 (by difference w/He from total flow out)

Pressure Setpoints:

Initial Pressure: 35.00 psi
Initial Time: 5.00 min.

PRESSURE PROGRAM

Level	Rate (psi/min.)	Final Pressure (psi)	Final Time (min.)
1	3.00	20.0	44.00
2	3.00	30.0	4.00
3	1.00	35.0	10.65

Total Run Time: 93.65 min.

Column Description/Configuration:

	Col. A	Col. B
Column Stationary Phase:	DB-1701	DB-5
Column Length:	30 m	30 m
Film Thickness:	0.25 μ	0.25 μ
Column I.D.:	0.25 mm	0.35 mm
J&W Scientific part #:	122-0732	122-5032

Connector: 3-way glass union (0.25 mm i.d.): part # 705-0731

Pre-column: 4 m undeactivated fused silica, 0.25 mm: part # 160-2250

Quality Control Procedures for PCB Data Analysis

Purpose:

This section describes the quality control criteria for evaluating analytical data obtained for PCBs. Where applicable warning and control limits are specified along with the required corrective action including re-extraction of samples, re-analysis of sample extract or noting any discrepancies when reporting final results.

Initial Demonstration of Method Calibration Standards

1. When establishing a method perform a method calibration on three replicates of each calibration standard to establish response over the desired range of concentrations.

2. Perform the extraction and analysis of seven replicates of a matrix containing PCBs at or below the lowest calibrated standard (1 ppb), spiked with 1 ppb of the calibration mixture. Establish the MDL as follows:

   $MDL = t_{(n-1=0.99)} \times S$

   Where:

MDL	=	Method Detection Limit
S	=	standard deviation of replicate analyses
$t_{(n-1=0.99)}$	=	Student's t-value for 99% confidence level with n-1 degrees of freedom

Quality Control Criteria for Calibrating Before a Sample Run

1. Linearity of calibration curve

   The warning limit is that the calibration standard cannot deviate from linearity by more than a correlation coefficient of $r^2 = 0.995$ for all analytes. Control limits are linearity with a correlation coefficient between 0.995 to 0.980 for more than one third of all analytes. Corrective action is diagnose for changes in flow, temperature and pressure systems, examine all suspect chromatograms, use integration event tools if applicable, re-establish new calibration curve.

Quality Control Criteria After A Sample Run

1. Continuing Calibration

No analyte can exceed a twenty percent difference in response between the beginning and end of a run, and a twenty percent absolute difference from a reference concentration at the beginning and end of a run. Corrective action is re-establishment of calibration curve and re-analysis of the batch.

2. Laboratory Control Material (LCM)

No more than a thirty percent difference in average percent recovery with no more than one-third of the individual analytes exceeding a thirty-five percent difference in recovery. Corrective action is noting exceedances in data package, review overall QC to determine if sample batch must be re-analyzed. If all weights, measures, instrument set points, etc., are accurate and there is no sample contamination causing the exceedance then report results. If sample integrity has been compromised then re-extract the LCM. If all other QC is intact then report results of second LCM analysis.

3. Laboratory Duplicates

Criteria is no more than a twenty five percent average relative percent difference (RPD) between duplicates, with no more than one-third of the individual analytes exceeding thirty-five percent. Corrective action is noting exceedances in data package, review overall QC to determine if sample batch must be re-analyzed. If QC is intact then re-extract the duplicate. If RPD still exceeds criteria note in data package and report second results. Relative percent difference is calculated as follows:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100$$

Where:

RPD	=	Relative Percent Difference
C_1	=	larger of two concentration values
C_2	=	smaller of two concentration values

4. Procedural Blanks

The warning limit is that the procedural blank cannot exceed the MDL by a factor of two for any one analyte based on the average weight for all samples contained in the batch. The control limit is that the procedural blank cannot exceed the MDL by a factor of three for any one analyte based on the average weight for all samples contained in the batch. Corrective action is to identify all associated samples as contaminated for each analyte in exceedance of the control limit. Procedural blanks with unstable or erratic baselines are suspect. Corrective action is evaluation of GC system and extraction/column cleanup.

all associated samples as contaminated for each analyte in exceedance of the control limit. Procedural blanks with unstable or erratic baselines are suspect. Corrective action is evaluation of GC system and extraction/column cleanup. Note any interferences with analyte quantification in the data package. Additional procedural blank may be required.

5. Reagent Blanks

Inspect reagent blanks to determine if sample carry-over occurred for analytes of interest. Corrective action is noting in the data package with concentration of analyte carry-over for each batch based on the average sample weight for the batch. If carry-over interferes with analyte quantification refer to sample carry-over section in "GC maintenance and troubleshooting" standard operating procedure and re-inject another aliquot of extract from affected samples.

6. Matrix Spike

Recoveries cannot exceed a range of eighty to one hundred and twenty percent for all analytes. Corrective action is to note any exceedances in data package. Check overall QC for sample contamination, accurate weights and measures, etc. If sample integrity has been compromised re-extract the sample.

7. Internal Standard

The warning limit range is that recovery cannot exceed a range of eighty to one hundred and ten percent for the response factor ratio between BZ# 198 (internal standard) and BZ# 103 or TCMX (internal recovery standard). Control limit range is seventy to one hundred and twenty percent. Corrective action is to note any exceedances outside the control limit range in data package and re-extract the sample.

8. Internal Recovery (Injection) Standard

The warning limit for the response factor ratio of the internal recovery standard is that it cannot exceed a difference of fifteen percent from a preceding batch. The control limit is that the response factor cannot exceed a difference of twenty percent from a preceding batch. Corrective action is to check overall QC for accurate weights and measures, and all GC operating parameters when control limit is exceeded. Note any exceedances (warning or control limit) in the data package. If control limit is exceeded in two consecutive batches initiate preventive maintenance on GC flow system.

9. Standard Reference Material

Matrix and criteria to be determined by project requirements. Acceptable materials are NIST cod liver oil and NRC-Canada CARP-1.

GC Maintenance and Troubleshooting for PCB analysis

Purpose:

This section identifies components of the gas chromatograph system that can cause contamination or otherwise interfere with instrumental analysis for polychlorinated biphenyls (PCBs). Both the hardware and software are under service contract. In most cases a failure of the electronic hardware or computer software will produce a fault notice to the user, in which case instructions will be provided in the equipment manuals for user remediation or to call for service. The following information will decrease reliance on calling for service. Most but not all of the information in this section is described more fully in the GC manuals, which should be read thoroughly before operating the GC or performing any maintenance or troubleshooting procedure.

Baseline Interference

Diagnosing baseline interference can be time consuming and frustrating. The following sequence of GC system component checks is recommended to save time:

1. Autosampler syringe
2. Injection port assembly
3. Guard column
4. Detector
5. Serviceable electronics

Whenever servicing or troubleshooting any component of the GC be certain that all consumables, such as ferrules, syringes, o-rings, etc. are H-P parts, or if from another supplier such as SUPELCO that they meet the specifications for the H-P replacement parts listed in the GC manual.

The most frequent causes of baseline interference will be wander, noise, ghost peaks, and spiking.

Wander, the undulation of a baseline, in most cases is caused by fluctuations in gas pressure (flow) usually when the septum (Supelco LB-2 Green) leaks. These septa can last for up to 100 injections according to the manufacturer. It is recommended that the septum be replace after fifty injections or if wander becomes apparent. Piercing the new septum with a manual syringe prior to using the autosampler syringe greatly reduces the chance of tearing the septum. Use of predrilled septa is not recommended as they tend to leak more rapidly than nondrilled septa. If this does not eliminate baseline wander then the flow system needs to be diagnosed for leaks. Contamination by nonlabile sample material should also be suspect, especially after running several dirty samples.

Noise, which is a steady fluctuation (rumble) of a constant baseline can result from several sources:

Gases:
Gas filters (Supelco OM-1) change color as they become saturated. When near fully saturated they should be replaced.

Injection Port Liner:
Small pieces of septum can be torn by the autosampler syringe and become lodged in the injection port liner. The liner can also become coated with non-labile materials after several injections of sample material. Replace the liner each month or sooner if noise or ghost peaks persists. Use only a single taper liner that has been baked in a muffle furnace. After baking add a plug of silanized glass wool. The glass wool plug should be approximately one-eighth inch long loosely packed two-thirds into the liner towards the tapered end. The viton o-ring seal is reusable. If it appears torn replace it.

Electron Capture Detector (ECD):
The ECD cell can become contaminated with non-labile sample residue after repeated use. Signal units between 20 and 60 are signs of contamination build-up. A thermal bake-out can be performed to clean the ECD cell. Refer to the manual. A thermal bake-out is recommended only after evaluating the entire GC system. If contamination problems persist after a thermal bake-out notify the laboratory radiation safety officer and arrange for a detector exchange with the manufacturer.

Ghost peaks are chromatographable material that appear in all injections (samples, blanks, reagents, etc.) but are not coming from sample. The two most likely sources are the autosampler syringe and the injection port liner.

Autosampler Syringe:
The HP7673 autosampler syringe is a notorious source of ghost peaks. Consultation with HP service technicians revealed the plastic needle guide can be a source of ghost peaks. It has been removed and replaced with an aluminum needle guide. A second source is from the rubber belt that operates the plunger. Small pieces of rubber can coat the plunger as it passes by the belt that rapidly moves up and down. With the syringe removed periodically place a kimwipe against the belt and run the belt up and down to minimize contamination. A dark halo at the top of the autosampler syringe around the opening indicates rubber contamination. Proceed as follows:

1. Remove the syringe from the autosampler (read the manual) and in a fume hood clean the syringe under vacuum using methanol, acetone, and hexane, in this order. After cleaning the syringe move the plunger back and forth through

the syringe then wipe it on a kimwipe and look for any dark residue. This cleaning step may have to repeated several times. If the plunger moves freely and there is no dark residue on the kimwipe proceed to step 2.

2. using the cleaned syringe set the oven temperature to 220°C @ 20 psi (pounds per square inch) carrier gas pressure and manually inject 1μl of hexane. Watch for ghost peaks during the next 20 minutes. If they appear repeat the injections until the peaks finally disappear, signalling that the syringe has been cleaned.

3. It is advisable to inspect and test the autosampler syringe before every sample run. If the plunger feels sticky or otherwise difficult to move clean the syringe and perform a manual hexane injection. If it still feels difficult to move the plunger, with or without the appearance of ghost peaks, replace with a clean syringe and clean the dirty syringe as above until it moves freely. Operating the autosampler with a sticky syringe invariably will destroy the syringe and could damage other autosampler components.

Injection Port Liner:
If septum material becomes lodged in the injection port liner or if several dirty samples have been run then subsequent injections can have ghost peaks. Replace the injection port liner if suspected after evaluating the autosampler syringe.

Guard Column:
The DB-5 column is equipped with a 5m guard column which can be shortened at the injector port end if noise, wander, or ghost peaks still persist. Refer to the manual for changing columns. Removing only 4 - 6 cm is recommended.

Spiking is a sudden rapid deflection off the baseline and is usually caused by electronic malfunction(s). Refer to the manual. Check all serviceable electrical connections for grounding problems. If spiking persists call for service.

Retention Time Drift
Changes in retention time of peaks usually indicates a change in gas pressures, effects of sample load on the column and/or changes in the behavior of the sample with the columns' stationary phase. Proceed as follows:

Gas flows/leaks
Check all flow rates with the bubble meter for any changes. Check the septa to see if it is leaking. Any change in carrier flow rate can result in a change in retention time. If retention times for calibrated peaks fall outside the calibration window either re-establish previous flow rates and re-calibrate or re-calibrate at new flow rates that approximate previous retention times.

Sample Affect
If a large amount of chromatographable material is placed on the column the retention times can be pushed back by the large peaks eluting from the column. If retention times are consistently delayed make sure the peaks of interest are identified within the calibration window. Also check for any sample carry-over between samples. If retention times are consistently delayed but are being accurately identified there is no need for remediation.

Column Affect
If retention times drift without consistency (some early, some late) suspect changes in column performance. The DB-5 column is a workhorse with a proven track record of withstanding deterioration from repeated use or overloading with sample material. Nonetheless, if retention times keep changing without consistency after checking all flow rates, checking for leaks, baking out overnight at 240°C and several subsequent test runs with the calibration standard then consider replacing the column.

Electron Capture Detector (ECD)
The following information will assist with the maintenance and troubleshooting of the ECD. With the exception of spiking, which is most often caused by an electronic problem, most of the causes associated with ECD interference can be traced to the flow system, performance design of the detector, or the wet chemistry.

Anode Purge:
The HP5890 is equipped with a new generation of electron capture detector (ECD) that includes an anode purge gas attachment. HP service technicians recommend not using this feature due to increase noise levels produced when make-up gas is purged through this new flow system. The valve providing make-up gas to the anode purge should be kept closed.

ECD Cell:
The GC manual provides a good description of the ECD cell and other detector components. The symptom produced by a defective ECD cell is a steady decrease in background signal units over several days until the ECD reads zero. Gradual decreases over several months can be corrected with the potentiometer located on the ECD board. Continued decreases in background below ten signal units after repeatedly adjusting the baseline using the potentiometer indicates the ECD cell is defective. Notify the laboratory radiation safety officer and arrange for a replacement through the manufacturer.

Detector Response:
The most common cause for changes in detector response to calibrated peaks (measured as area units) is a change in make-up gas flow rate. There is a range of flow rates that will produce detector responses in the range of calibration

currently in use. At a low make-up gas flow rate the ratio of carrier:make-up gas is increased thereby increasing the detector response, i.e. a greater proportion of sample material from the column is passing through the detector. Unfortunately this is accompanied by a higher level of baseline noise due to low make-up gas flow rates. Conversely, at higher make-up flow rates the ratio of carrier:make-up gas decreases and the pressure inside the detector cell increases. These two effects (decreased proportion of carrier:make-up gas and increased gas pressure in the detector cell) tend to flatten and smooth-out a baseline but reduce the detector response. If flow rates have not changed, the system is leak-free, but detector response decreases over several runs then consider the following possible source of decreased response.

A second possible source of reduction in detector response can occur if the ECD cell becomes "quenched" meaning sample material is covering enough of the plated surface to decrease response. Normally this will be accompanied by higher levels of baseline noise and can be remedied by a thermal detector bake-out. Refer to the manual to become familiar with the operational principles of the ECD. Attempt a thermal detector bake-out only after all other possible sources have been ruled-out.

Changes in detector response should be consistent for all analytes (either all increasing or decreasing). If not then check all aspects of the wet chemistry procedures. Sometimes a change in materials used in the extraction/clean-up can affect the recovery of analytes, especially with changes in Florisil used as the clean-up stationary phase. Check if a new batch of Florisil, solvents, etc., was used or if any other method changes occurred. Although this effect is rare it has happened. If there are no changes in the wet chemistry and the GC flow systems are O.K. then suspect changes in the column stationary phase. If the column needs to be changed refer to the manual for instructions.

Sample Carry-Over

During the course of running several samples some of the material from one injection may not elute completely off the column and "carry-over" to the next injection. The reagent blank (hexane) placed within a series of sample injections serves as a monitor for carry-over which often appears as unresolvable (no peaks) material eluting in the reagent blank injection. Provided the carry-over does not interfere with the quantification of analyte peaks the carry-over is not a problem. If it does interfere with analyte quantification then the final time for baking-out the column at the end of the temperature program needs to be extended to allow sufficient time for all sample material to clear the column before the next injection. When extending the temperature program the pressure program needs to be extended by the same amount of time. Refer to the GC manual.

A bake-out time extension in excess of ten minutes to eliminate carry-over is indicative

of more serious problems. An extensive bake-out (hours or even days) can be necessary to eliminate sample material that routinely persists as carry-over after adjusting the temperature program. This usually indicates incomplete sample clean-up or sample contamination during the wet chemistry operation. Incomplete clean-up occurs when sample components intended to be retained on the Florisil column elute into the final extract. Contamination during wet chemistry that causes carry-over can occur from exposing the sample to plastics such as gloves or other plastic material. The most frequent source of carry-over contamination from plastics is a group of compounds known as pthalate esters which are common to most heat-cured plastics, and for which the ECD is highly sensitive. If carry-over is a persistent problem a review of all sample handling and wet chemistry procedures is necessary to identify and eliminate any source(s) of the carry-over.

APPENDIX F

Massachusetts Division of Marine Fisheries
Shellfish Management Plan Outline

MASSACHUSETTS DIVISION OF MARINE FISHERIES

SHELLFISH MANAGEMENT PLAN OUTLINE

(Annotated)

I. Brief Community Description

A. Population
B. Coastline (miles & type)
C. Shellfishing area (approximate acreage)

*This may be very brief, 1-2 short paragraphs giving an overview of your city/town's demographics and available shellfish area.

II. Historical Background

A. Catch statistics
B. Propagation activities (brief overview of major historical activities used.)
C. Commercial fisheries
D. Recreational fisheries
E. Aquaculture
F. Diseases, die-offs, fish kills
G. Community structure for managing resources (i.e. role of a shellfish advisory board if applicable)

*This section can utilize graphs and/or charts to show summaries and trends of historical data. Some brief narratives may be necessary or beneficial, particularly for (B),(F) and (G).

III. Budget Breakdown

A. Personnel (Salaries)
B. Equipment
C. Propagation
D. General Expenses

*This can be a copy of Form 1 of Application For Reimbursement sent annually to the Division.

IV. Shellfish Resources (Include maps)

A. Status of Shellfish Areas
    1. Town management of areas
    2. State DMF classifications
B. Accessibility
    1. Shore vs. boat only
    2. Public access
C. Resource and Habitat mapping
    (See V. below also)

*Maps, maps, maps! It is helpful to have 1-page town maps to use for (A) and (B). Resource and habitat mapping should be broken down by area.

V. Marine Resource Planning

A. Recreational and Commercial Shellfishing
B. Shellfish leases (Aquaculture grants)
C. Moorings and marinas
D. No discharge zones
E. Waterskiing, jetskiing, etc...
F. Docks & piers

*Harbor Management plans or the like may be used. It's a good idea to prioritize the most important shellfish areas to protect them from potential conflicting uses within town. List any areas which are zoned for specific purposes, like mooring or dock free zones, aquaculture lease zones, etc.

VI. Resource Management

A. Relays and Transplants
B. Seed grow-out Programs
C. Predator Control Programs
D. Area rotations
E. Law enforcement
F. Future plans

**THIS IS THE MEAT OF YOUR MANAGEMENT PLAN!* Outline your short and long term goals and plans for shellfish propagation and management. Be specific on short term plans. You may want to include a chart on seasonal areas for relay planning if applicable. Note work in progress as well. It is useful to document what has and hasn't worked in the past.

VII. Shellfish Lease Program

A. Policy
B. Number and locations of existing leases
C. Estimated production (species and amounts)

*A map of existing leases is useful here.

VIII. Water Quality Programs

A. Priority list of mitigation projects
B. Potential intern projects
C. Sanitary survey/Triennial review schedule

IX. Shellfish Permits

A. Numbers
B. Fees
C. Requirements

*Very briefly list types of permits issued and their respective fees. If the town has specific residency time requirements or other requisites, make note of it.

IX. Rules & Regulations

*Your updated shellfish regulations

XI. Other

A. Public Education Programs
B. Special Projects

*this can be a brief description of important related activities going on or being planned for your city/town or region.

Amendments to the Annual Shellfish Management Plan

1) List any major changes that occurred such as classification changes to an area; major storm erosion or shifting; shellfish mortalities or diseases, etc.

2) List any pollution source updates and/or changes such as drainage mitigation, septic updates along the waterways, dredging projects, marina pumpouts, etc.

3) Give a brief annual report on shellfish propagation activities which actually took place for that year including relays, transplants, seed grow-out, predator control, etc. Document your observations: problems, mortalities, growth, condition of shellfish, habitat suitability, etc.

4) Update your plans for the following year.

5) Give an anticipated budget.

If you have any questions relative to this outline or should need assistance with the devlopment of your plan, contact DMF biologist Dave Whittaker @ (508) 563-1779, ext. 126.